INTEGRATED EDITION OF THE PETROLEUM ENGINEER

the Petroleum Engineer

FOR MANAGEMENT

DECEMBER 1959

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THE PETROLEUM Engineer

FOR MANAGEMENT

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THE PETROLEUM Engineer
FOR MANAGEMENT
INTEGRATED EDITION OF THE PETROLEUM ENGINEER

THE PETROLEUM Engineer
DRILLING AND PRODUCING
SPECIALIZED EDITION OF THE PETROLEUM ENGINEER

REFINING Engineer
SPECIALIZED EDITION OF THE PETROLEUM ENGINEER

PIPELINE Engineer
SPECIALIZED EDITION OF THE PETROLEUM ENGINEER

As Invisible As ***Santa Claus***

YOU'RE ON A VACATION motor trip — you, the wife and the three chips off the two old blocks. You stop at the service station and say "fillerup." (You've only come 90 miles since the last service station, so you know the tank can't hold much, but somebody in five is always needing a stop.)

The family piles out and heads for the rest rooms. You go in and get a free map to check the route again and ask the manager "Where's a good place to eat on the highway?"

The men outside wipe the windshield and since the top of the car is mostly glass — wipe all the way around. One checks the tires and then the oil.

"A quart low, sir."

"I need an oil change in another 500 miles. Will it do till then?"

"It'll do."

The automatic hose has turned off. Your tank is full. It took five gallons of gasoline. You pay $1.58 and you and your family roar off, knowing that the next hundred miles you'll have a choice of many other service stations to hold your hand, so to speak, on this journey of yours.

DID YOU KNOW that the man who told you the best highway to take and where you could get a good meal, who gave you the map, supplied the rest rooms, hired the men who cleaned your windows and checked your oil and battery and tires, netted less than a nickel on your visit?

He has a mark-up of some 27 cents on the gasoline but he has to pay employees, rent, taxes, buy equipment and supplies, collect excise taxes and pass them on, and make contributions to community affairs out of that 27 cents.

You paid the government — federal and state — 51 cents (national average on five gallons) mostly for the highways you ride on, but also in some states for pensions, teachers' salaries, welfare funds, administration — whatever state officials decide the tax should be spent for.

The remaining 80 cents you gave the service station goes to an army of people . . . to the wholesaler, who has those big tank trucks that keep the station supplied with gasoline (did you ever go into a station that had run out of gasoline? You're one in a million if you have) . . . to the pipeline, railroad, barge or truck company that transported the gasoline from the refinery to the wholesaler . . . to the refinery that transformed a viscous crude oil into the sparkling energy you bought so nonchalantly for your machine . . . to the pipelines or tankers for carrying the crude oil to the refinery . . . to the producers who bring the oil from deep below the earth's surface . . . to the engineers who study the problem of recovering two barrels of oil where only one could be counted on before . . . to the drillers who sweated a pipe down to the right spot to tap an oil reservoir . . . to the explorers who combed the land to find an indication of petroleum trapped 5000 or 15,000 feet beneath the earth they stood on . . . to the farmer who owned the land above the pool . . . to lawyers, to accountants, to managers. You can imagine how little profit is left from these myriad operations for the companies that handle them.

WHERE IN ALL THE WORLD could you find such a buy as the five gallons of gasoline you bought to carry your car and you and your family and your luggage almost a hundred miles?

And why are you so unaware of the bargain you have won — so oblivious to the achievement behind your purchase?

In this Christmas season we feel that the petroleum industry, like parents, has simply preserved a myth that it is another Santa Claus — pulling gifts from a bottomless sack. Some day, some time, our customers must learn (as Dear Virginia was told) that our industry is a spirit, too — a flaming spirit of enterprise and courage, an intense spirit of research and exploration, a determined spirit of economics and logistics. Our gifts are not drawn from a magical bag. They are worthy products of mind and inspiration and labor.

We are not Santa Claus and never have been. But the industry's accomplishments are also a great marvel.

Ernestine Adams

Congrats and $25 for this quip to G. A. KRAFT, 17 Van Berwaerdeweg, The Hague, Netherlands.

To the men on the rig and the men at headquarters . . . Lone Star casing, tubing, and line pipe mean fine steel stamina and the convenience of quick supply so important in the oil and gas industry.

Quality control is basic at Lone Star . . . from ore to finished products. Ultra modern manufacturing facilities plus multiple, exacting inspections guarantee absolute satisfaction with Lone Star API Pipe.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

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The new *Century* Pumping Units . . . designed by you for tomorrow's pumping!

Yes . . . "Oilwell's" new *Century* series Pumping Units were actually designed by the men who will use them. An extensive survey told us what you wanted in this kind of equipment . . . and now, as the oil industry starts its second century, we have designed, tested, and re-tested these new units to make them as safe and dependable . . . as simple and economical to maintain . . . as you requested.

Primary structural elements—frame, samson post, beam, equalizer and pitmans . . . are made from the proper steels, rigidly welded for utmost strength and perfect alignment. Front legs of the samson post are widely spaced on the T-shaped base to provide solid footing and assure stability throughout their operating range.

Wearing parts, such as gears, bearings, equalizer pins and wrist pins, are carefully engineered with adequate capacity for heavy-duty service. Positive grease or oil lubrication systems are provided to minimize wear and simplify maintenance procedures.

Roll-Back Arc is generously designed to provide full support, and its track-type face spaces the arc cables for easy installation of sucker rod rotator or dynamometer, either above or below the yoke. The slant-slot yoke simplifies installations and removals.

The Type G Cranks make maximum use of counterweights and are easier than ever to adjust, with operator working safely to the side of the unit and always having positive control of the weight. Height of the reduction-gear subbase allows the weights to clear the floor with several inches of safe toe room.

Routine maintenance is done at ground level. When the samson post-ladder is used, a welded and braced safety loop supports the mechanic.

With every wanted feature indicated by composite opinion, these new *Century* Pumping Units set new standards—in ease of maintenance as well as in performance.

For further information write or ask for a free copy of our booklet, "*A new Century.*"

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Petroleum Profile

"ON A RECENT INSPECTION TOUR of two of our company's newest compressor stations, I was again impressed by the remarkable technical progress which continues to typify Texas Eastern and the great gas transmission industry."

To people who know Orville S. (Dick) Carpenter it was no shock when he did not use such currently popular words as "surprised" or "amazed" in his article for Texas Eastern Transmission Corporation's magazine, *The Inch*. With his knowledge of gas industry innovations, Mr. Carpenter does not need to express surprise or amazement at such "technical progress" as new satellite compressor stations powered by the largest gas turbines ever used for natural gas transmission.

Know-how and love of hard work are among the many traits which Dick Carpenter put to good use during his rise to the presidency of Texas Eastern. Those traits are now being readily utilized by the $834 million corporation. Texas Eastern's near 8000 miles of natural gas and petroleum products pipeline, as well as extensive facilities for oil refining, gas processing and oil and gas production, place it as one of the nation's largest pipeline companies.

In an era when success in the rapidly growing pipeline industry depends to a considerable degree upon skillful financing, its president is well qualified to guide Texas Eastern's operations. He has been closely associated with the financial affairs of the company since shortly after incorporation in 1947 to bid for the war-emergency built Big Inch and Little Inch pipelines.

He served as comptroller with the original group who organized the company. He was promoted to a vice presidency in 1950 and to the top post in the fall of 1956. As president, he has directed the most extensive expansion and diversification program in the company's history — a program still in progress as evidenced by the new satellite stations to which he referred.

But more than technical progress is involved; his leadership goes far beyond mechanical development. Mr. Carpenter's far-sighted vision and keen scrutiny of operations involving Texas Eastern are responsible for much of the company's dynamic growth.

A further indication of his leadership is shown by the caliber of the executives brought into the company since he became president — such men as Paul R. Haas, administrative vice president; Millard K. Neptune, senior vice president in charge of the Little Big Inch Division; and John F. Lynch, senior vice president in charge of the Oil Division.

He has not simply encouraged rapid technical advancement of the pipeline but has also taken a leading position in diversifying the company into other, related fields designed to protect the interests of Texas Eastern customers.

For instance, after more than two years of litigation before the Federal Power Commission and weeks of negotiation between companies, Texas Eastern in July purchased an entire gas field. At that time, the company received the blessing of one of the nation's stiffest regulatory agencies, the FPC, for the endeavor. This one project added nearly one trillion cubic feet of gas to the company's reserves and thus improved the ability of the company to meet customers' demands for many years.

The flare for finance and administration typified in Texas Eastern operations is illustrated by young Dick's career that began after education at Meridian College in Mississippi and a brief tour of duty in World War I.

After the war, he worked for various accounting firms from 1919 to 1927. At that time he entered public accounting practice in Wichita Falls and Dallas, Texas, becoming increasingly successful. In 1935 he became Texas state auditor and was admitted to the Texas Bar.

ORVILLE S. CARPENTER
President
Texas Eastern Transmission Corporation

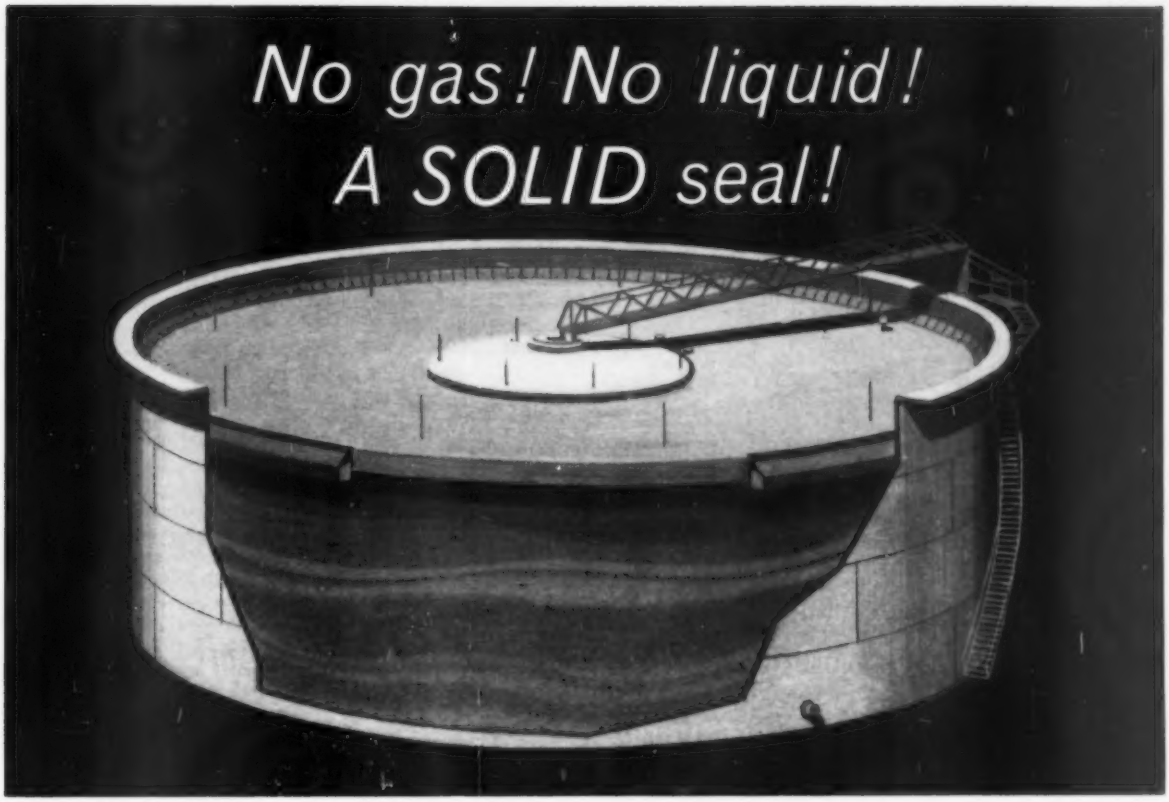
In 1936 - 37, he served as executive director of the Texas Old-Age Assistance Commission and from 1937 - 40 earned recognition for his work as chairman and executive director of the Texas Unemployment Compensation Commission.

Entering the Army in September 1940, he was administrative officer of the Texas Selective Service system from 1940 to 1943. After a year as regional officer in the national Selective Service headquarters, he was assigned in 1944 to the Headquarters for the Military Government of Germany. Separated from the Army as a lieutenant colonel in 1945, Carpenter was awarded a presidential commendation for his war service. He returned to public practice as a certified public accountant and attorney in Austin, Texas, before joining the new Texas Eastern organization in 1947.

A director of the American Gas Association and the Independent Natural Gas Association of America, Mr. Carpenter is also a member of the American Institute of Accountants, American Bar Association, Texas Bar and the Louisiana and Texas Societies of Certified Public Accountants, Controllers Institute of America and National Association of Cost Accountants.

Mr. Carpenter and his wife, the former Mary Evans of Wichita Falls, have two children, Mrs. John L. Daniel and James Orville (Dickie) Carpenter. Mr. and Mrs. Carpenter make their home in Shreveport but he spends much time at the company offices in Houston and along the pipeline route — which may take him from the Mexican border to New York. Occasionally Carpenter can be found in New York discussing business on Wall Street or in Washington, D.C., on matters relating to the Federal Power Commission.

Combining his forceful personality with knowledge of the business and new developments, Mr. Carpenter's widespread influence has proved beneficial both to Texas Eastern and to the pipeline industry.



nothing can disable

EverSeal*

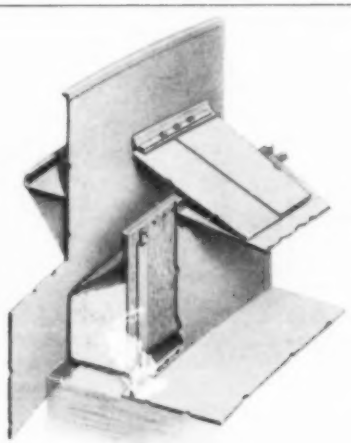
General American's new cushion seal for floating roofs

Tear it! Gouge it! Puncture it! The seal will hold. No matter what the damage, it will not burst or rupture! There's nothing in EVERSEAL to spill or leak.

Urethane cushions firmly joined and enclosed in a vapor-tight, no-scuff envelope of BUNA "N" and PVC are protected by the General American weather hood.

EVERSEAL resists the abrasive action of rough tank walls, yet will not scratch or damage tank coatings.

Get the complete details about EVERSEAL! Write the General American office nearest you. For any type of conservation structure, *it pays to plan with General American.*



WHY THE NEW GENERAL AMERICAN EVERSEAL IS FAR BETTER THAN ANY TUBE TYPE SEAL

1. No liquid or gas to leak
2. Replace entire seal or a section without taking roof out of service
3. EVERSEAL will accommodate a 10" variation in annular space between roof and shell
4. No moving parts—nothing to corrode
5. Costs less than most other seals
6. Permits full travel of roof, yet rides easily over projections on shell and maintains seal
7. Protected from sun, rain, snow and dirt by the General American weather hood
8. Eliminates buildup of vapors in seal area
9. Will not freeze to sides of tank
10. Provides full protection for oxygen-sensitive stocks

*PATENTS PENDING

Plate & Welding Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

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THE CONFERENCE TABLE

"A sweeter Christmas than we to ours . . . May you bequeath to yours." . . . OGDEN NASH

Who Manages Whom?

As Standard Oil Company of Indiana reports in the third quarter, (See Page A-16b) it is operating "three struck refineries at about half of the usual crude throughput mainly with dedicated supervisory and technical personnel."

The issue is whether union leaders or company management will do the managing. As the third quarter report says: "The issue in the strikes is whether management is to be bound by rigid union contract requirements, or is to be free to determine in a reasonable manner the number of people to be employed and to what duties they are to be assigned. We continue to maintain that it is our responsibility to manage our operations as efficiently as possible. For example, to keep our manufacturing costs low and competitive, we must make large capital investments in new and modern refinery equipment. To operate these facilities as economically and efficiently as possible, management must be able to determine what jobs and what job assignments are economically justified."

Deductibility Rules Published

Meantime, the Internal Revenue Service decided on a new approach in its three-year effort to establish regulations limiting the deductibility, for income tax purposes, of expenditures made for lobbying purposes. After withdrawing regulations it had proposed, but never finalized three years ago, the Service published a new set of regulations, invited public comment and indicated public hearings may be held prior to putting these into effect.

The new rules specifically exclude as deductible items all expenditures made, directly or indirectly, for the promotion or defeat of legislation, for political campaign purposes, or for carrying on propaganda, including advertising, related to such purposes. However, dues to a trade association or labor union would continue to be deductible for income tax purposes, unless a "substantial" part of the organization's activity is deemed to be lobbying. A deduction will still be allowed for that portion of a payment to an association that is attributable to non-lobbying activities.

Several bills are now pending in Congress to make all, or part, of such expenditures deductible and while the subject may be discussed during this fall's tax revision hearings by the Ways and Means Committee, congressional leaders thus far have shown no disposition to push for action in this field.

From Western Oil & Gas Association The *Week in Review*, September 25, 1959.

✔ ***A small debt produces a debtor; a large one, an enemy . . .*** — Publius Syrus

A Pat for Oil and Gas

The Pioneer, Little Rock, Arkansas, a printing and lithographing company, had this to say about politics recently:

"As we had every reason to expect, Congress has now set up a commission to make a study and 'do something' about the coal industry. Thus we not only have the expense of some people stirring the situation around, but the natural progression is that we will soon start buying up coal and storing it somewhere. Of course this will not change in the slightest most people's perfectly natural preference for oil, gas or electricity whenever they are able to come by it. They are not only cleaner to work with, but are so much easier to start and stop.

"Whatever cost advantage coal may ever have had has largely disappeared as Mr. Lewis improved the pay and perquisites of his membership. Already about a quarter of the miners are miners no more, but all this will undoubtedly be taken care of when the commission really gets going. They'll be digging up coal and renting buildings to store it above the ground, all at the expense of you know who.

"Is it any wonder that they have difficulty sustaining a market for government bonds! No one has had the temerity to come right out and say so in public, but it is no secret to anyone who pays the slightest attention to such things that government bonds are selling consistently at quite a few points under par. We might even suggest that it is a little dishonest to urge people to buy them on patriotic grounds when the politicians blithely undermine their value with one inflationary give-away after another. If this be treason, tell your Congressman. He's the one that's doing it — not us."

Libya and Land Mines

You're always running into the unexpected when you reach out to unfamiliar lands to search for oil. In Libya you have to count on clearing mines laid in the desert battle ground of World War II.

Field Marshal Montgomery of the Allied forces and the famous "Desert Fox" Rommel, fought back and forth

British Petroleum Photo

across the worthless (then) desert and at each retreat another crop of mines was laid.

Now the story is changed. Exploration crews advance across the endless sands to find oil and gas. (Page E-1). In the British Petroleum photograph shown a crew is mine-hunting before the explorers can work. Supervisors are usually former German and British officers.

How to Fight Inflation . . .

SUPPORT sound economic policies in government.

INSIST on a balanced budget.

STOP pressuring Congress for appropriations which are not absolutely necessary.

ENCOURAGE our representatives to resist that kind of pressure from others.

DEMAND that states and communities pay their own bills . . . and refuse invitations to extravagance based on the argument that Washington will pay at least part of the cost.

USE RESTRAINT as wage-earners in making pay and fringe benefit demands.

HOLD FIRMLY as employers to the principle that increased wages can be justified only by increased productivity.

CONTINUE in industry to seek every possible means of offsetting higher costs by greater efficiency of operations . . . and resort to price increases only when there is no other way to solve the problem.

From the July 1959 issue of SERVICE, published by Cities Service Company; William H. Walsh, Managing Editor.

Husky to Merge

Canadian Husky Oil Ltd. will acquire common stock of Husky Oil Company, Cody, Wyoming, according to plans announced by Glenn E. Nielson, president of both companies. Husky Oil, founded by Nielson in 1938 is fully integrated. Canadian Husky began in 1947 as a subsidiary and was separated in 1953. Now they are to be merged again.

Depreciation Allowances Inadequate

American living standards and the strength of the nation for defense are gravely threatened by "grossly inadequate" depreciation allowances to industry under the federal tax law, wrote Thomas Crawley Davis, vice president, the Du Pont Company, in the *Tulane Alumni Business Review*.

His editorial "The Hidden Disease of Industry," said that industry is "obliged to operate in an inflation economy under a disastrously unrealistic depreciation policy. The dollar that went into plant and equipment in 1941, the last year before the era of inflation began, had shrunk to 41 cents in 1958 — a 59 percent decline in purchasing power. Yet depreciation set-aside allowed by present income tax law remain unchanged, as if the dollar would still buy as much plant as it did in 1941."

✔ *In spite of the large population of this planet, men and women remain today the most inaccessible things on it . . .* — Frank Moore Colby

Economic Forecasting Is Tool

Short and long range economic forecasting was the subject of a panel discussion held by the Industrial Instrument Section of the Scientific Apparatus Makers Association.

Long-range forecasting — usually covering a five-year period — definitely has become an important tool in today's business world, was the consensus. However, economic "crystal gazers" could be just as wrong in certain instances as weather forecasters, the panelists agreed.

One company official pointed out that his firm utilized task forces made up of representatives from sales, engineering and manufacturing to derive their long-range forecasting. It was their job to analyze the company's present standing and then pool their information in order to determine where they would be 5 or 10 years hence.

Short-range-forecasting generally was based on an extension of past performance, including such factors as any changes in the market caused by economic trends, technological changes or new applications of the product.

In another panel that followed, dust and foreign material were listed among chief reasons for the need of repair services in electronic instruments along with damage resulting to items en route to the consumer.

One major goal, a panelist explained, was effectively reducing the delivery cycle of an item returned for repair regardless if it is in or out of warranty. It was generally agreed that delivery could be speeded up if accurate and complete information could be obtained from the customer on the nature of the exact complaint.

Carl Mahurin, Hewlett-Packard Co., moderated. Panelists included Harry Lang, Boonton Radio Corp., Marvin Steinberg, Sensitive Research Instrument Corp., and Charles Titcomb, Kin Tel, division of Cohu Electronics, Inc.

Opening New Doors

In the union vs management fight on automation we tend to forget that the work machines can do is really the most boring kind. William Bright brings this point out in his chapter on Human Relations in the "How to be a Manager" series (Page E-9). He says, "Technological advance tends to reduce industrial frustration. It frees man for more challenging and rewarding work."

Management has the responsibility of emphasizing this truth and duty of making the transition to more satisfying labor more secure.

Management to School

Nine Tidewater Oil Company executives in the West are returning to the classroom temporarily this year as part of the Flying A firm's continuing executive development program, now in its eighth year.

The 1959 program participants are attending five leading universities across the country which offer a concentrated course of study adapted to the professional needs of business managerial personnel. The Tidewater men represent a wide range of petroleum industry experiences, from oil exploration to gasoline marketing.

Selected for the current year's program from Tidewater are Richard A. Ny, treasurer; Henry H. Neel, foreign exploration and production manager; Don T. Whalen, western division marketing manager; and Charles J. Lee, western division chief accountant.

Other 1959 participants are J. M. Tharp, Jr., coastal district production superintendent at Ventura; Glenn A. Hill, Oregon district marketing manager; Arnold Nelson, employee relations supervisor at Tidewater's Avon refinery; David G. Cowie, executive assistant to the oil purchase and exchange manager; and William B. Tyson, staff assistant in the foreign exploration and production department.

The Tidewater executives participating in the executive development program this year are taking their managerial educational courses at Columbia, Cornell, Stanford and Pittsburgh Universities.

Highlights

★ ★ ★

Demand Rises in West Europe

In the first six months of 1959 West German oil consumption has further increased. In the months January through June a total of 10,712,678 tons were consumed, a rise of 23.5 percent over the first half year 1958.

United Kingdom consumption of petroleum products in the first half of 1959 rose to 17.8 million tons, an increase of 2½ million tons, compared with the like period of 1958. This is a 16 percent rise.

Proposals for Emergency Program

The National Petroleum Council presented nine key recommendations for the "National Emergency Oil and Gas Mobilization Plan of the Government," as result of a study under the chairmanship of Walter S. Hallanan. Foremost was the provision that oil and gas operations be handled by the Department of the Interior with the Secretary of Interior as administrator.

The council has submitted 868 nominations of qualified industry personnel for reserve positions in the emergency organization. Copies of the report are available from National Petroleum Council, Washington, D. C.

Outlook Brightens

Demand, new supply, and inventory trends all became more favorable in September, according to the petroleum department of Chase Manhattan Bank. The report said that September showed a gain of 4.8 percent over last year, with the year including September up 5.0 percent. Prices continue uneconomic, but they reflect the statistical condition of the past rather than what lies ahead, it was stated.

Seeks To Restrict Gas Use

A spokesman for the natural gas industry attacked current efforts of the coal industry to establish a so-called "national fuels policy." The effort, embodied in legislation now pending in the Congress, is the latest step in a 20-year endeavor by the coal industry to restrict the competitive market for natural gas and "by government intervention to obtain competitive advantage," said John A. Ferguson, executive director, Independent Natural Gas Association of America. He made his charges in a document filed with the Subcommittee on Automation and Energy Resources of the Joint Economic Committee.

Bid for Colon Oil Company

Canadian Shell and its subsidiary, Compania Shell de Venezuela, Ltd., two major companies in Royal Dutch/Shell group, made offers to Colon Oil Company, Ltd., which, if accepted, would result in the acquisition of the outstanding minority interest in Colon. Canadian Shell now owns 96.1 percent of Colon's outstanding shares. Colon operates in Venezuela and has a current production of approximately 20,000 bbl per day.

Independents Form Company

In line with current trends of mergers of independent operators, Petroleum Investments, Inc., was formed at Shreveport, Louisiana, by a group of prominent oil operators. Charles W. Glasscock, formerly of Glasscock Drilling, is chairman of the board; George J. Despot is president; Charles O. Hardey, Hardey Company, is vice president, and O. P. Avinger, Jr., a partner of Heard, McElroy and Vestal, is secretary-treasurer. Directors are: H. L. Kirkpatrick, of Kirkpatrick and Associates; B. A. Hardey, a former president of IPAA; George Despot and Robert A. Stacy, independent oil operators.

The company first acquired producing mineral properties and expects to develop into an integrated oil operation.

Fire Damage Rises

Fire losses in petroleum facilities rose sharply last year, according to a report by National Fire Protection Association. Damage and destruction of refining and bulk storage plants cost more than $16,500,000 in 1958, against about $11,300,000 the year before. The non-profit service organization's estimates also show an increase in number of fires in these facilities, from 1500 to 1800.

Financial Frankenstein

W. F. Rockwell, Jr., president, Rockwell Manufacturing Company, reports in his company's advertisement: "One of our people has figured out that federal, state, and local governments would have to own 80 percent of our outstanding shares to get as much revenue from us in dividends as they now do in taxes."

That gives you pause, doesn't it?

Win Annual Report Oscars

Awards for the best corporate annual reports of the year as selected in the 19th survey conducted by *Financial World*, national magazine, were presented to the nation's leading corporations at a banquet in New York City, October 26, 1959.

For larger oil companies, Continental Oil Company won the Bronze Oscar. Standard Oil (Indiana) was second, and Atlantic Refining, third.

For smaller petroleum firms, Texas Pacific Coal and Oil was awarded the Oscar (for the third time), Home Oil Company, Ltd., was second, and White Eagle was third.

Hamilton Rogers, executive vice president of Texas Pacific Coal and Oil, receives Bronze Oscar for his company's 1958 annual report from Richard J. Anderson, editor and publisher, *Financial World*.

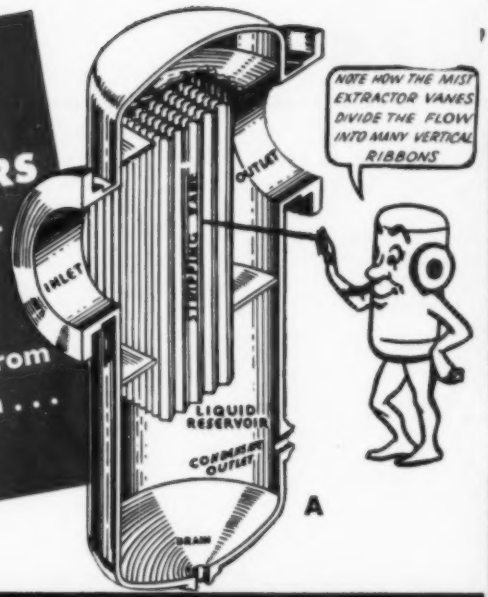
These six companies' annual reports were chosen from 81 entries in the petroleum division.

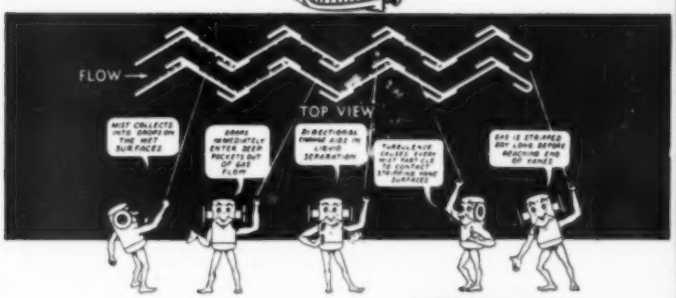
Special Oscars were awarded Sinclair Oil in the post-meeting reports division and Ohio Oil Company in the annual report advertisements division.

In the pipeline division, Northern Natural Gas received the Oscar, Panhandle Eastern was second, and Alabama-Tennessee Natural Gas third.

PEERLESS LINE SEPARATORS

Outstanding for the efficient extraction of liquid mist from gas or steam . . .




B
FLOW
TOP VIEW
MIST COLLECTS INTO DROPS ON THE VANE SURFACES
DROPS IMMEDIATELY ENTER DEEP POCKETS OUT OF GAS FLOW
BI-DIRECTIONAL CHANGE OF DIRECTION AIDS IN LIQUID SEPARATION
TURBULENCE CAUSES GAS TO CONTACT ENTRAINED LIQUID ON VANE SURFACES
GAS IS STRIPPED DRY LONG BEFORE REACHING END OF VANES

HIGH EFFICIENCY—HIGH CAPACITY LOW PRESSURE DROP

Thousands of installations throughout the Refining and Chemical industry have proven the Peerless Line Separator principle to be one of the most outstanding methods available for the extraction of liquid from gas, steam or air.

Drawing A above shows the arrangement of the vanes in the Separator. Drawing B is an illustration of the Peerless principle.

The mist extractor combines the forces of impingement, centrifugal motion and surface tension to obtain its high efficiency. The path of the gas, etc., through the unit is constantly bending, causing semi-violent turbulence and rolling of the gas against the walls of the vane. Impingement and centrifugal force combine to contact the droplets with the vanes, where they coalesce, and surface tension then causes them to cling to the vanes' surfaces. Gravity and the impact of the gas stream then drives the droplets into the pockets where they roll down the vanes and out of the gas stream.

Through the Peerless method of mist extraction, the gas is stripped dry long before reaching the end of the vanes.

there's A PEERLESS SEPARATOR FOR EVERY REQUIREMENT

For any capacity
For any working pressure
For corrosive conditions
With removable vane units
With extra body length
With connections for accessory equipment
For pressure drop requirements of less than 6" water
For any vapor-liquid ratio
For any piping requirement

SPECIAL DESIGN SEPARATORS FOR ANY REQUIREMENT

FOR FURTHER INFORMATION ON THE USE OF PEERLESS LINE SEPARATORS PLEASE WRITE FOR NAME OF NEAREST PEERLESS ENGINEER.

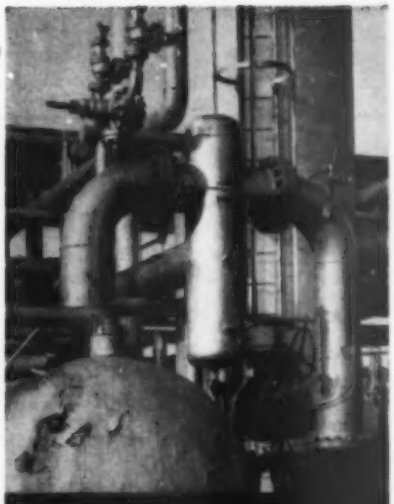
PEERLESS MFG. CO.

"OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE"

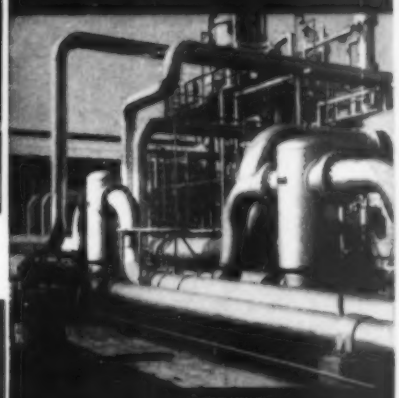
PEERLESS MANUFACTURING CO.

P. O. BOX 13165 ★ DALLAS 20, TEXAS ★ FLeetwood 2-8431

REPRESENTATIVES IN ALL PRINCIPAL CITIES



A Peerless Line Separator is shown above removing entrainment from a refinery reboiler.



Peerless Line Separators are doing an effective job of mist extraction at this Kentucky Petrochemical Plant.

This is an insulated Peerless Steam Separator on a turbine driving an airblower.

Highlights ★ ★ ★

Rathbone Heads API

M. J. Rathbone, president of Standard Oil (New Jersey), was elected chairman of the board, and Frank M. Porter, president of Fain-Porter Drilling Company, was re-elected president of the American Petroleum Institute. Rathbone succeeds H. S. M. Burns, president of Shell Oil Company.

Elected API vice president for transportation at the Institute's 39th annual meeting was Henderson Supplee, Jr., president of The Atlantic Refining Company.

Officers re-elected were: Clarence H. Thayer, Sun Oil, vice president for refining; C. J. Guzzo, Gulf Oil, vice president for marketing; L. E. Fitzjarrald, Phillips Petroleum, vice president for production; and W. J. Arnold, Pure Oil, vice president for finance and accounting.

P. C. Spencer, Sinclair Oil Corporation, New York, was re-elected treasurer, and Willard M. Wilson was re-elected secretary.

Cuba Jails Data

The Cuban government, which already has levied stiff new taxes on mineral production, moved against all foreign oil exploration companies by sealing their office files. Among the companies affected were Texaco, Atlantic Refining, Union Oil of California, Standard Oil of California, Gulf, Standard N. J., and Shell.

Agents from the ministry of public workers, who entered the companies' offices without warning, said the government is preparing to draft a new petroleum law and wants all the technical information that is in the hands of the companies.

Morocco Next?

Algeria has gone through an oil boom and is set on a rising production scale. Libya is "hottest spot" on the globe right now. Will the independent kingdom of Morocco, neighbor on Algeria's northwest, be next? Prime Minister Moulay Ibrahim and Director of Cabinet Csi Naceur Ben Layrbi of Morocco visited the United States this fall and in Dallas, Texas, let it be known they were interested in attracting outside oil capital. New petroleum law went into effect in 1958.

Contracts for Russian Crude

Marquard & Bahls GmbH., Hamburg, recently signed a contract with Sojus Neft Export, Moscow, covering supply of 850,000 tons of gasoline, kerosine, gas oil, lubricating oil and fuel oil in 1960. A great portion of this quantity is to be imported into West Germany within the framework of trade agreement allocations. Another portion is destined for transit trade transactions.

In the first six months of 1959, West Germany's receipts of oil products and tar from the Soviet Zone of Occupation amounted to 299,591 tons at a value of about $20 million, which is a new record.

Philadelphia Salutes Centennial

The William Penn Desk and Derrick Club of Philadelphia sponsored a celebration of the Oil Industry Centennial at a dinner October 27 in the Warwick Hotel. More than 300 top oil industry leaders and their wives attended. A panel discussion highlighted the program. Members were Miss Hildegarde Dolson, New York, author of "The Great Oildorado" (Random House, 1959); Mrs. Ruth Sheldon Knowles of Tulsa, Oklahoma, author of "The Greatest Gamblers" (McGraw-Hill, 1959), and Miss Ernestine Adams of Dallas, management editor, *The Petroleum Engineer*. Panel moderator was Milburn Petty of Washington, D. C., editor of *Oil Daily*.

Texas National Expands

Properties of Utah Southern Oil Company will be purchased by Texas National Petroleum Company of Houston, according to a recent proposal. Sale price would net Utah Southern $19,200,000 and would increase Texas National's holdings in the Rocky Mountain region. Ralph A. Johnston is board chairman and W. Stewart Boyle is president.

End Use Authority Denied

An appellate court in Philadelphia set aside a government order denying permission to Transcontinental Gas Pipe Line Corporation to transport natural gas to New York City for Consolidated Edison to use as boiler fuel. The U. S. Third Circuit Court of Appeals ruled FPC over-stepped its authority and ordered it to issue the permit, subject to further hearings on rates. The issue was whether Con Edison's use of the gas to fire boilers wasted natural resources.

World Production Rises

World production of 523,765,000 bbl of crude petroleum in March 1959 was slightly above the February level, and 13 percent greater than in March 1958. United States crude output in March was 15 percent over the same month in 1958; Venezuelan output was 19 percent greater; and the Middle East 8 percent above March 1958. Increased crude output in major producing areas during the 12-month period reflects the recovery from the effects of the economic recession of 1957-58, and the rising trend of world oil demand.

Tulsa Firm on American Exchange

Helmerich & Payne, Inc., common stock now traded over-the-counter, was admitted to trading on American Stock Exchange, New York, November 6, 1959. Helmerich & Payne has 1,891,000 shares outstanding, held by more than 3600 stockholders in 45 states. The stock has been publicly owned since 1952 although the history of the company itself dates back to 1919.

Receives Foundation Award

Iowa College Foundation presented the 1959 honor award to Standard Oil Foundation, Inc., of Standard of Indiana. In accepting the award from Marvin M. Schmidt, President of Iowa College Foundation, J. Howell Turner (left) said his company worked five full days in 1958 to generate a profit equivalent to the sum contributed to worthy causes. Schmidt pointed out that financial support of education and public welfare was important but that aid in establishing state associations of private colleges was also fruitful.

Good Wells Make Good News

A Monthly Report On Wells That Are Now Worth More

December, 1959

This month, the jobs reported are more of those engineered by Dowell with the aid of the "Frac Guide"*. You will notice the excellent results.

- Greenwood County, Kansas (New Oil Well) This open hole completion was made into the Bartlesville sand from 1837 to 1862 feet. Production was only one bopd. Dowell engineers recommended Waterfrac on the basis of calculations made with the "Frac Guide". 5000 gallons gelled water with FLA* (Fluid Loss Additive) and 20,000 pounds sand were injected down casing at 27 bpm and 800 psi. Five days after treatment, well was flowing 100 bopd with only a show of water.

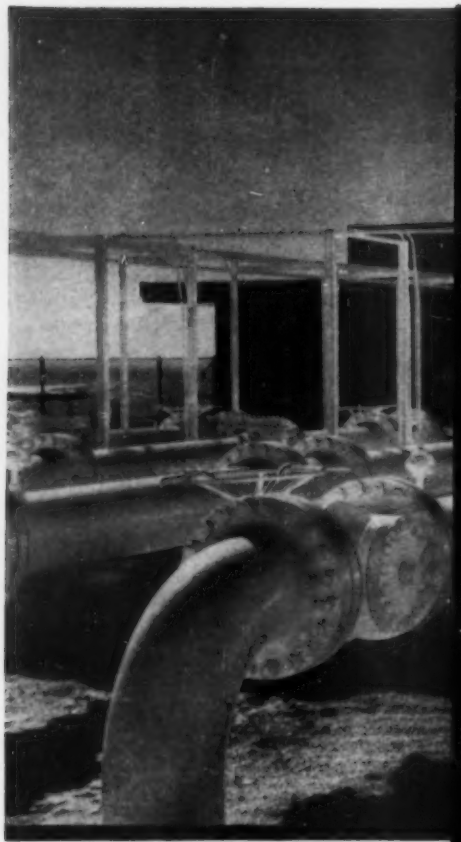
- Brazoria County, Texas Gulf Coast (Old Gas Well) Gas production had declined to only 417 mcfd. Pay was the shaly Frio sand from 6214 to 6224 feet. The "Frac Guide" indicated the use of Acid Petrofrac*. Dowell injected 5000 gallons acid-oil emulsion and 15,000 pounds 40-60 sand at 6 bpm and 4400 psi. Treatment was made through tree down 2⅜-inch tubing, allowing the operator to avoid using a workover rig. Production rose to 9000 mcfd — more than a twenty-fold increase.

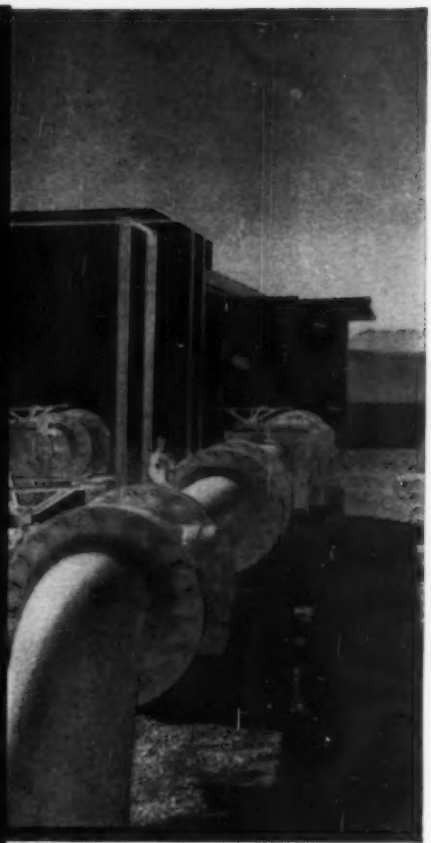
- Glasscock County, West Texas (Old Oil Well) This Spraberry well had depleted both the lower Spraberry and the shallower Clearfork. The operator plugged off both these zones and re-completed into the upper Spraberry by perforating the casing from 6870 to 6905 feet. Then Dowell engineered a treatment with the "Frac Guide" using 10,000 gallons refined oil, a fluid loss control agent, 35 perforation ball sealers and 45,000 pounds sand. After treatment, which was down 3-inch tubing, the well potentialed 93 bopd.

- Montague County, North Texas (New Oil Well) This well swabbed only one boph after completion into the conglomerate through three sets of perforations between 5852 and 5928 feet. Dowell engineered a four-stage down-casing fracturing treatment that included 40,000 gallons gelled crude, 60 ball sealers, 2000 pounds of a fluid loss control agent and 94,800 pounds sand. Before the treatment, 500 gallons of Mud Acid was used to wash the formation and the well was swabbed. After treatment, well tested 432 bopd, flowing on ½-inch choke.

In area after area, Dowell continues to get improved results with the "Frac Guide". Take advantage of this experience to help you get the results you want. For service or detailed information, contact the Dowell office or station nearest you. There are more than 165 locations in the United States, Canada, Venezuela and Argentina. Dowell, Tulsa 1, Oklahoma. *Dowell Trademark

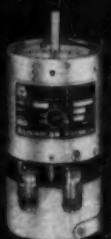
Services for the oil industry DOWELL
DIVISION OF THE DOW CHEMICAL COMPANY





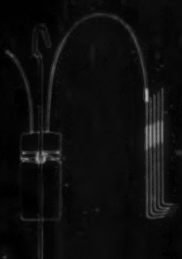
ORIFICE METERS

American-Westcott Dri-flo and mercury manometers in recording, indicating and integrating models—to 5000 psi working pressure.



GASCLOK

Gas or air-operated instrument power drive and timing unit for remote installations.



CANNON PENS

Controlled-flow capillary meter pens record up to a full year without refilling—eliminate chart smearing and blurring.

CONTROLLERS

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R-018

Earnings 18 Percent Higher Than 1958

Comparison in third quarter shows leveling off. Earnings margin struggles for some gain... still low for risk industry

THIRD QUARTER EARNINGS of the petroleum industry rose 5 percent and the first nine months of 1959 showed an 18 percent increase over the same period in 1958. This estimate is based on returns from 60 companies.

Margin gain on income is slight. Last year profit from revenues for the first three quarters was 7.2 percent. This year it rose to 8.1 percent. For a risk industry this is a low margin to work on. As usual, results varied widely. As you can see from the table, trends are hard to find.

Some remarkably good financial records were made at the end of the third quarter in spite of supply problems, heavy inventories and soft prices. Petroleum companies fought economic hazards with greater efficiency.

Anderson-Prichard forged ahead with 32 percent increase in the third quarter—a 77 percent rise for the first three quarters over 1958.

Several smaller firms made phenomenal gains. Some had gone in the red in 1958. Delhi-Taylor, Colorado Oil and Gas, Aztec, Murphy, Quaker State, Union Oil and Gas of Louisiana, Woodley, and Helmerich and Payne are some with spectacular increases in earnings, both for third quarter and first nine months.

Of the larger companies, Sun Oil has a 42 percent increase for nine months despite a slight drop in the third quarter. Phillips and Continental earnings went up 34 percent and both had substantial rises in the third quarter.

Other large companies with increases in third quarter as well as for the first nine months are Richfield, Ohio Oil, Sunray Mid-Continent, and Texaco. Jersey Standard gives only cumulative figures but using six-month estimates, its third quarter and nine month earnings both showed increases.

Third Quarter Doldrums

The third quarter, by comparison with last year, showed much less increase, principally because the third quarter of 1958 was much higher than the first two.

Report of Standard Oil Indiana stated the drop of 20 percent in the third quarter was due to labor difficulties and a broad weakness in product prices. There were short strikes at the company's Whiting and Wood River plants and continuing strikes at Texas City, El Dorado, and Sugar Creek refineries.

Universal Consolidated Oil, a Los Angeles firm, blamed imports for its 14 percent decrease in the third quarter. The company, however, shows a nine-months increase of 25 percent.

Both Standard Oil of California and Union Oil of California were down 4 percent from last year for the nine months report.

Union stated: "Total petroleum demand for the West Coast industry is up about 8 percent in barrels in the first nine months of 1959. Despite this improvement, the industry is still troubled with burdensome inventories and depressed product prices. Much of the demand gain represents depressed price sales of surpluses in the highly competitive markets not normally served by the Pacific Coast, such as the East Coast and Far East. Gasoline prices continue to be unstable throughout the West Coast marketing area."

The 20 percent decline for Skelly was explained thus: "... refined products prices reflected the general industry oversupply, and severe proration (only 9 producing days were permitted each month in Texas, for example) held crude oil production well below that for the year-earlier period."

Decrease of Atlantic Refining's earnings in the third quarter was due in part to lack of income from sale of its Eastern Hemisphere marketing subsidies, received in the same 1958 period. Softer prices and steel strike also affected returns.

Texas Pacific Coal and Oil attributed its 15 percent decline in the third quarter to reduction in allowable producing days in Texas.

Third quarter earnings for Sinclair fell 15 percent from the 1958 period, although the company maintained a rise for the nine-months period. The report stated: "Prices realized for refined oil products were unrealistically low, and in some instances below the unsatisfactory level of a year ago."

Capital Expenditures

Jersey Standard indicates it will pay more attention to short term gains and will reduce capital investment slightly. In the first nine months the company spent $658 million, down 15 percent from 1958. It appears, however, that other companies may well balance this loss to capital expenditures. Standard of California is carrying out its $400 million program, up 17 percent from last year.

Continental has increased its capital expenditures 21 percent over 1958 in three quarters, bringing them to $69 million. Union Oil of California brought its expenditures to $67 million, 32 percent higher than last year.

Forecasts

Most statements are optimistic about the future. Clark Oil and Refining, which had a 50 percent increase for the first three quarters, reported "that sales and earnings will continue at a satisfactory level for balance of the year."

Atlantic's report stated: "The forward look for the industry is somewhat brighter. The cumulative effect of continuing restrictions on both domestic production and imports, plus the more realistic levels of refinery runs in recent months, should begin to bring about significant corrections in product inventories which, in turn, should improve the price situation."

Reports Delhi-Taylor: "The price for heating oil has firmed with the approach of cold weather, and the basic increase in domestic demand for all refined materials, coupled with moderating industry-wide crude runs, make it reasonable to expect a continuing trend toward a higher level of product prices over the fourth quarter and into 1960."

Prediction of Standard Oil Company (Indiana) was "Even if the strikes continue until year end, we estimate that fourth-quarter earnings will be better than those for the third quarter of 1959 and about equal to the results for the fourth quarter of 1958. We are operating the three struck refineries at about half of the usual crude throughput mainly with dedicated supervisory and technical personnel."

Sinclair Oil Corporation's view is that "petroleum is still a growth industry, and will continue to be the primary source of energy to power the world-wide march of progress." ★ ★ ★

Ernestine Adams

TABLE 1. PETROLEUM INDUSTRY FINANCIAL REPORTS FOR FIRST NINE MONTHS.

(All in $1000's)

Company	Third Quarter						Nine Months					
	Gross			Net			Gross			Net		
	1958	1959	% Change	1958	1959	% Change	1958	1959	% Change	1958	1959	% Change
Ambassador	909	1,632	+80	(161)	198	+223	2,501	4,220	+ 69	(777)	378	+150
Amerada	25,345	24,107	− 5	5,677	5,902	+ 4	76,416	76,633	± 0	16,527	17,563	+ 13
Anderson-Prichard	17,687	18,840	+ 7	1,380	1,823	+ 32	51,364	54,865	+ 7	2,757	4,867	+ 77
Argo	3,286	3,610	+10	1,480	1,029	− 30	9,528	10,674	+ 12	3,810	3,636	− 5
Atlantic	123,959	123,704	± 0	11,513	7,575	− 34	388,386	401,231	+ 3	19,180	23,975	+ 25
Aztec	1,270	2,200	+73	735	1,439	+ 96	2,852	6,142	+115	1,326	4,096	+209
Bishop	595	422	−29	53	(669)	−1362	1,737	1,383	− 20	98	(20)	−120
Champlin O & R	20,909	21,005	+ 1	2,150	1,840	− 14	58,682	63,801	+ 9	5,044	6,144	+ 22
Cities Service	232,747	225,891	− 3	7,693	8,396	+ 9	751,456	733,821	− 2	25,760	27,301	+ 6
Coastal States	819	1,445	+76	252	417	+ 59	2,429	4,174	+ 72	804	1,369	+ 70
Clark O & R	—	—	—	—	—	—	53,020	63,821	+ 20	1,282	1,921	+ 50
Colorado O & G	8,417	12,287	+45	(706)	731	+204	24,349	34,201	+ 40	(111)	1,765	+1690
Continental	191,322	204,047	+ 7	13,210	16,170	+ 22	549,322	587,840	+ 7	33,853	45,330	+ 34
Cosden	21,980	23,520	+ 7	1,229	1,430	+ 16	58,567	64,701	+ 10	3,216	3,834	+ 19
Crescent	—	—	—	1,156	379	− 67	—	—	—	1,302	1,761	+ 35
Delhi-Taylor	15,392	21,606	+40	(341)	1,267	+471	47,564	64,555	+ 36	(1,056)	2,727	+358
Douglas[3]	—	—	—	—	—	—	16,386	16,465	± 0	(87)	521	+699
Eason	926	885	− 4	183	6	− 97	3,131	2,826	− 10	605	284	− 53
Falcon Seaboard	—	—	—	—	—	—	—	—	—	585	636	+ 6
Felmont	2,516	2,122	−16	561	480	− 14	7,295	6,864	− 6	1,503	1,795	+ 19
Frontier	9,271	9,182	− 1	440	352	− 16	22,712	24,640	+ 8	606	591	− 2
General Crude	3,091	3,406	+10	794	806	+ 2	8,539	10,297	+ 21	1,768	2,525	+ 43
Gulf	—	—	—	—	74,661	− 16	—	—	—	—	216,475	+ 6
Helmerich and Payne	3,323	3,467	+ 9	(659)	(40)	+ 94	10,122	10,301	+ 2	(464)	204	—
Honolulu	10,021	11,009	+10	3,010	3,825	+ 27	29,930	33,297	+ 11	8,595	10,057	+ 17
Louisiana Ld. & Expl.	8,134	10,055	+24	4,114	4,968	+ 21	24,182	28,310	+ 17	12,975	14,136	+9
Maracaibo	438	443	—	80	55	—	1,373	1,334	—	219	193	—
Midwest Oil	4,863	4,953	+ 2	1,656	1,493	− 10	14,018	15,497	+ 11	5,003	4,964	− 1
Monterey[1]	5,164	5,552	+ 8	389	572	+ 47	16,150	17,054	+ 6	1,745	1,819	+ 4
Mountain Fuel Supply	3,517	3,430	− 2	(70)	(201)	—	18,318	20,680	+ 13	2,258	2,533	+ 12
Murphy Corp.[1]	9,187	12,691	+38	266	855	+221	23,530	37,668	+ 60	1,684	2,891	+ 72
Nortex	—	—	—	16	64	+400	1,393	1,043	− 28	27	117	+333
Ohio Oil	67,470	115,316	+71	7,940	8,766	+ 10	200,876	259,306	+ 29	23,028	27,323	+ 19
Phillips	264,272	284,469	+ 8	21,198	24,177	+ 14	776,705	882,048	+ 14	57,609	77,386	+ 34
Plymouth	20,579	20,515	−31	1,356	612	− 55	63,849	69,071	+ 8	2,876	2,796	− 3
Pure	114,396	121,372	+ 6	6,741	6,094	− 10	348,185	373,115	+ 7	17,416	19,242	+ 10
Quaker State	12,142	13,537	+11	529	759	+ 43	36,371	41,406	+ 14	1,340	1,763	+ 32
Richfield	70,698	70,500	± 0	4,855	7,494	+ 54	193,856	201,732	+ 4	15,255	18,189	+ 19
Shamrock[1]	14,816	15,158	+ 2	2,174	2,051	− 6	42,787	43,461	+ 2	6,691	6,836	+ 2
Shell	427,366	455,551	+ 7	35,161	34,868	− 1	1,231,634	1,347,244	+ 10	89,032	104,055	+ 17
Signal	37,697	35,787	− 5	4,425	3,866	− 13	109,705	117,706	+ 7	12,751	12,525	− 2
Sinclair	281,618	293,961	+ 4	9,458	7,993	− 15	874,092	915,103	+ 5	31,814	35,025	+ 10
Skelly	63,231	61,006	− 4	6,995	5,589	− 20	185,635	192,121	+ 3	17,543	20,111	+ 15
Socony Mobil	—	—	—	46,400	45,900	− 1	—	—	—	109,400	123,000	+ 12
Southland Royalty	2,459	2,323	− 6	884	913	+ 3	6,907	7,396	+ 7	2,741	3,158	+ 15
Standard (Calif.)	453,390	433,194	− 4	71,008	61,962	− 13	1,261,573	1,245,853	− 1	187,744	180,115	− 4
Standard (Ind.)	473,578	495,540	+ 5	34,026	27,338	− 20	1,393,488	1,492,577	+ 7	86,449	106,189	+ 23
Standard (N. J.)[2]	2,008,000	2,064,000	+ 3	146,000	162,000	+ 11	5,728,000	6,020,000	+ 5	395,000	477,000	+ 21
Standard (Ohio)	88,655	92,594	+ 4	6,038	4,670	− 23	267,487	283,041	+ 6	17,474	17,959	+ 3
Sun	198,483	182,150	− 8	11,062	10,177	− 8	533,154	567,465	+ 6	22,622	32,151	+ 42
Sunray Mid-Cont.	95,235	149,100	+57	8,829	10,847	+ 23	274,810	341,045	+ 24	28,090	30,783	+ 10
Texaco	—	—	—	89,100	96,893	+ 9	—	—	—	228,317	261,854	+ 15
Texas Gulf	4,166	3,763	−10	907	787	− 13	12,069	12,537	+ 4	2,524	2,879	+ 14
Texas Pacific C & O	6,223	6,385	+ 3	1,813	1,541	− 15	17,023	19,600	+ 15	4,166	5,183	+ 24
Tidewater	144,944	137,057	− 5	(607)	9,199	—	408,657	415,473	+ 2	(328)	27,832	—
TXL[1]	2,817	3,100	+10	941	914	− 3	8,287	10,010	+ 21	2,535	3,156	+ 24
Union Oil of Calif.	108,109	109,121	+ 1	9,373	9,129	− 3	309,236	319,516	+ 3	20,830	19,900	− 4
Union O & G of La.	7,663	9,590	+25	1,654	3,025	+ 83	24,299	32,266	+ 33	5,745	9,700	+ 69
Universal Consol.	2,080	2,020	− 3	804	695	− 14	6,458	6,193	− 4	1,928	2,416	+ 25
Wilcox	2,077	1,588	−24	216	245	+ 13	5,772	4,998	− 13	586	668	+ 14
Woodley	1,990	2,334	+17	753	951	+ 26	5,665	6,778	+ 20	2,034	2,706	+ 33
TOTALS	5,699,242	5,932,542	+ 4	581,091	609,830	+ 5	16,602,832	17,625,415	+ 6	1,542,260	1,821,813	+ 18

( ) Loss

[1]3rd quarter ends August 31.

[2]Jersey gives only cumulative earnings so third quarter is our estimate using 6-month figures.

[3]For 6 months ending September 30.

HARSHAW

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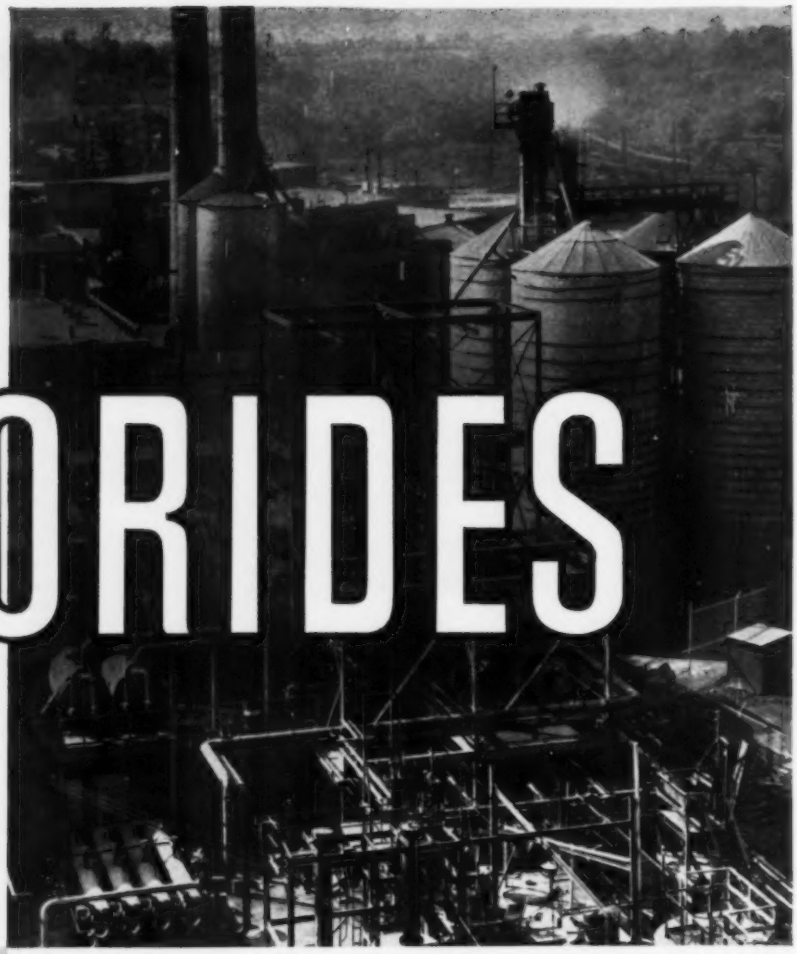

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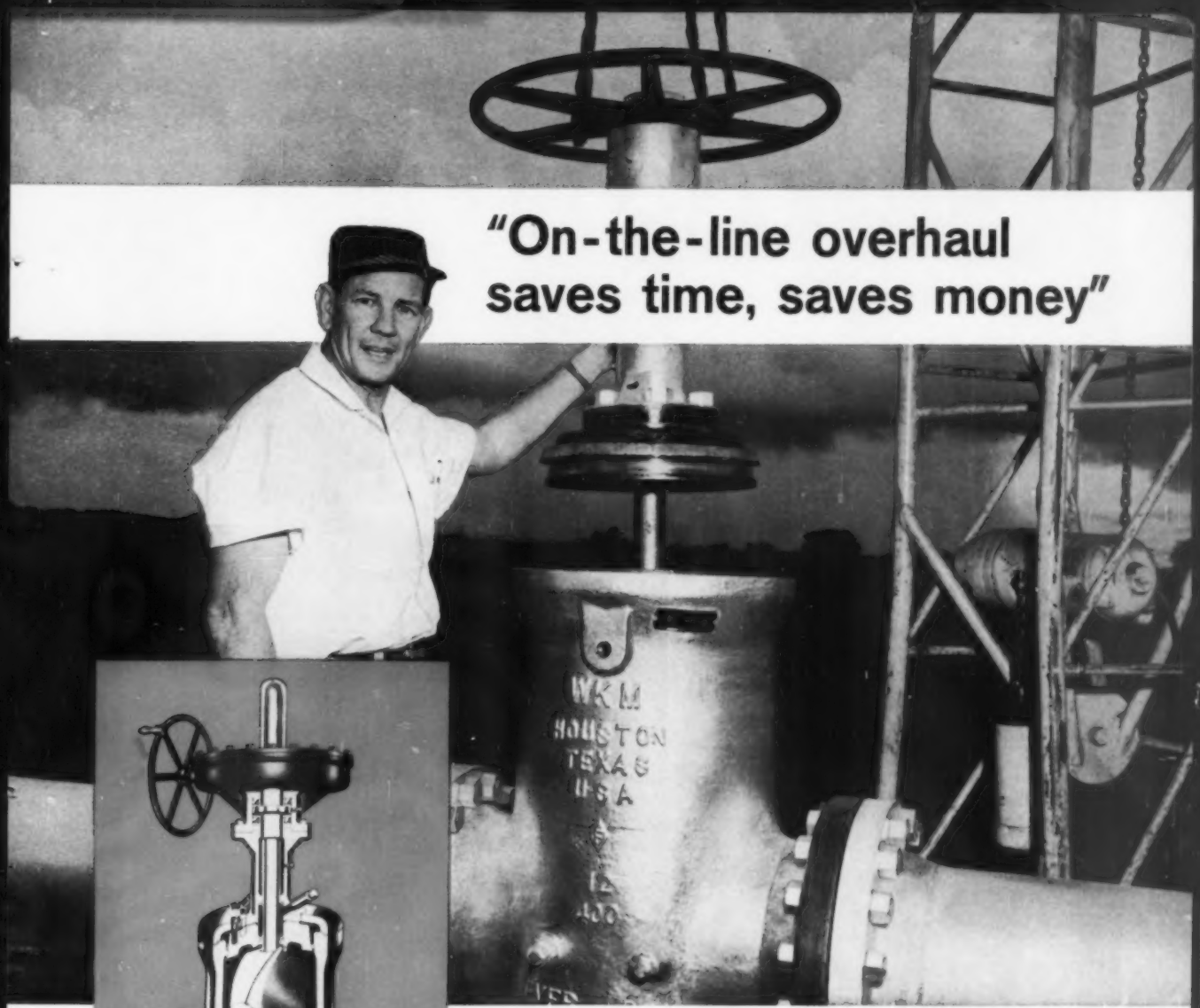

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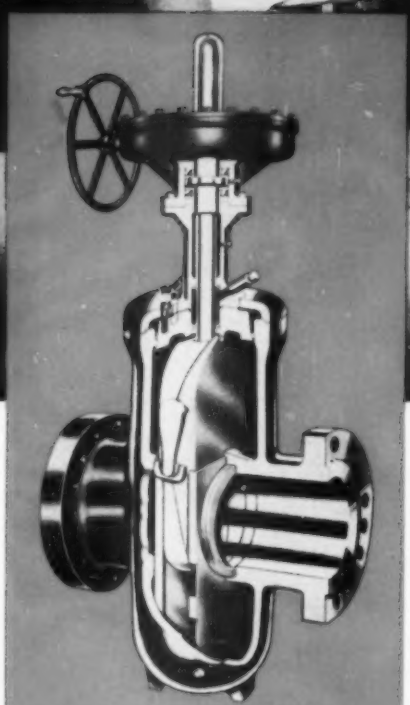

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Ernestine Adams

WHEN THE FIRST United States Minister was appointed to the United Kingdom of Libya in 1951, President Truman expressed the wishful thought than an oil strike might one day make the desert bloom.[1]

Like a faithful Arabian legend, a crop of derricks appeared on the desert sands and there is indeed a bloom—or more prosaically—a boom.

And the sensible geni who handles these things in the East provided that all three provinces (each as rabid states-righters as our Southern states) should have oil fields.

The first bloom was appropriately made in the poorest province, Fezzan, an arid region of some 244,000 sq miles and only 40,000 inhabitants, mostly roving Berbers.

The discovery well was in the first concession made under the new petroleum law passed in 1955. In November of that year Esso Standard (Libya) was the first company to be awarded a concession. It drilled two dry holes before Atshan No. 2 came in from 2100-36 ft (Devonian sand) with about 500 bbl a day of 44.5 gravity oil. The date was January 20, 1958.

But to go back a little, you should know that the United Kingdom of Libya was set up on December 24, 1951 by the United Nations. During World War II when the Allies under Montgomery and the Axis under Erwin Rommel, the Desert Fox, fought back and forth across the desert sands, the Italians, who considered Libya part of its African empire, were driven out. The British took over the administration of the north part of Libya and the French administered the Fezzan Province, which joined Algeria and French Africa.

Never was an independent nation begun under such a handicap. It is a poor country, mostly agricultural, but still food had to be imported. It was a country that had never ruled itself. The Tunisians, the Romans, the Vandals, the Byzantines, the Arabs, the Normans, the Spaniards, the Turks, the Italians had all conquered and ruled the desert kingdom.

Somehow, in 1951, the provinces, not particularly friendly, were united. King Idris I, formerly Emir Mohammed Idris El Senussi, ruler of Cyrenaica, was established as first king of a hereditary monarchy. Members were elected to Parliament, and the Kingdom of Libya was begun.

There wasn't enough money to run the government so its support had to come from the United States, which has a military air base near Tripoli, and from Great Britain, which maintains military forces in the country.

Petroleum Law in 1955

When Libya became an independent sovereign state very little was known about the geology and the petroleum prospects of the country. The state could not afford to risk the huge expenditure necessary to carry out geological investigation so in 1953 a brief Minerals Law was passed authorizing the grant of exploration permits to interested companies. Nine U. S., British, Dutch and French companies began exploration under this law.

In the meantime the petroleum law was being prepared and went into effect in July 1955. Any company may apply to obtain a permit concession. It is entirely within the discretion of the government acting through the Minister of Economy and the Petroleum Commission to rule upon the eligibility of the applicant.

Eligibility concerns the financial and technical capacity of the applicant, his previous activities and experience, and depends upon his compliance with the laws and regulations. In speaking of the first applicants, the commission said "In accordance with the provision, a number of applicants were rejected because of their activities in Israel or because of their financial or technical incapacity, or because of the absence of a suitable program of work . . ."

Personnel of Commission

The Petroleum Commission is made up of the following: Tahir Bishti, chairman, and Mohammed Asseifat, deputy chairman; Salim Seif al Nasr, member; Anis al Qasem, member and legal adviser. Director of Petroleum Affairs is A. Hogenhuis. All petroleum in Libya is the property of the state and all applications are made through these representatives of the state.

The petroleum law divides operations into two stages — a preliminary exploration stage, for which a permit is granted for one year, renewable, and a concession stage, for which a concession is granted for a maximum period of 50 years, with possible extension of 10 years, including a minimum 5 years or a maximum 10 years exploration period, during which the final concession acreage is chosen, with the obligation to reduce the original granted area to 33⅓ percent of its original size.

Libya is divided into four zones:

Zone I	**Tripolitania**	**NW**
Zone II	**Northern Cyrenaica**	**NE**
Zone III	**Southern Cyrenaica**	**SE**
Zone IV	**The Fezzan**	**SW**

A maximum is established for both the area and number of concessions in each of the four zones that may be held by one concession holder at one time. At specified periods the concession holder must relinquish a percentage of each concession. This is to encourage exploration by the holder and it has certainly done that.

Miss Adams is Management Editor.

[1] "Libya, The New Arab Kingdom of North Africa," Henry Serrano Villard, Cornell University Press, Ithaca, New York, 1956.

Basic financial agreements for concession holders are divided into four main groups:

1. Fees: A fee of £L500 ($1400) upon grant of each concession.
2. Rent: Annual rent on a graduated scale.
3. Royalty: 12 percent of value of crude oil and natural gasoline produced.
4. Income tax.

If fees, rents, royalties, taxes and imports do not reach 50 percent of profits, company pays surtax to raise to 50 percent.

Profit is defined as income after deducting: (1) Expenses and losses, (2) amortization on physical assets, and (3) 25 percent depletion allowance.

TABLE 1. OIL IN LIBYA

Discovery	Date	Company	Concession	Prod. depth	Formation	Tested
Atshan No. B 2-1	Dec., 1957	Esso Stan.	No. 1	2100-36′	Devonian	500 b/d 44.5°
Bahi No. A1	July, 1958	Oasis	No. 32	5822-54′	Cretaceous (?)	700 b/d 38°
Dahra No. B1	Dec., 1958	Oasis	No. 32	3758-3808′	Paleocene	1000 b/d 38°
Tahara No. B1	Dec., 1958	CPT (L)	No. 49	7587′ TD	Carboniferous	100 b/d 47°
Tahra No. F1	April, 1959	Oasis	No. 32	3685′		700 b/d
Tlacsin No. 1	Apr., 1959	Libyan-Shell	No. 70	8884-980′	Devonian	650 b/d 41.5°
Zelten No. 1	June, 1959	Esso	No. 6	5428-660′	Paleocene	17,500 b/d 37°
Emgayet No. 1	June, 1959	Gulf	No. 66	4080-100′	Devonian	888 b/d 37.9°
Mabruk No. 1	July, 1959	Libyan-Am.	No. 17	3100′ 5711-714′ 5774-78′	Cretaceous	2500 b/d
Zelten No. 2	Aug., 1959	Esso	No. 6	5770-915′	Paleocene	15,000 b/d 39°
Amin		Amoseas	No. 47			2000 b/d
Beda No. 1	Aug., 1959	Amoseas (Caltex)	No. 73	4035-85′	Paleocene	3650 b/d 36.6°
No. A1	Aug., 1959	Oasis	No. 26	5719-40′	Mississippian	Tests 37°
Amal No. 1	Oct., 1959	Mobil	No. 12	9841-10,405′	Pre-Cretaceous	865 b/d 34°
Zahaligh	Oct.1959	Libyan-Am.	No.17	3,263-386′	Cretaceous	800b/d

CONCESSIONS SHOWN ON MAP OPPOSITE

Block No.	Company	Area Zone	Sq. Km.[1]	Acres	Granted
1	Esso Standard (Libya) Inc.	4	20,788	5,136,299	20 Nov. 55
2	Nelson Bunker Hunt	2	11,753	2,902,991	20 Nov. 55
3	Esso Standard (Libya) Inc.	1	10,932	2,700,205	12 Dec. 55
4	(Jersey Standard)	1	3,087	762,490	12 Dec. 55
5	" " "	1	1,722	425,335	12 Dec. 55
6	" " " "	2	25,690	6,345,430	12 Dec. 55
7	" " " "	2	1,310	323,570	12 Dec. 55
8	" " " "	1	11,852	2,927,445	12 Dec. 55
9	Mobil Oil of Canada Ltd.	1	2,017	498,200	31 Dec. 55
10	(Socony Mobil 75%,	1	2,283	563,900	31 Dec. 55
11	Geisenberg 25%)	1	19,004	4,693,988	31 Dec. 55
12	" " " "	2	8,004	1,976,988	31 Dec. 55
13	" " " "	2	6,893	1,702,571	31 Dec. 55
14	" " " "	2	7,818	1,931,046	31 Dec. 55
15	" " " "	2	797	196,859	31 Dec. 55
16	Libyan American Oil Co.	1	3,709	916,481	12 Dec. 55
17	(Texas Gulf Producing	1	4,476	1,106,004	12 Dec. 55
18	and W. R. Grace)[2]	2	7,163	1,769,953	12 Dec. 55
19	" " " "	2	7,437	1,837,657	12 Dec. 55
20	" " " "	2	4,708	1,163,330	12 Dec. 55
21	Cancelled				
22	Cancelled				
23	Compagnie des Petroles Total	1	14,900	3,680,300	31 Dec. 55
24	(Libye)—(C F P)	1	6,214	1,534,858	31 Dec. 55
25	Oasis Oil Company	1	8,374	2,068,378	12 Dec. 55
26	(Ohio, Amerada, Conoco)[3]	4	53,572	13,236,570	12 Dec. 55
27	" " " "	2	869	214,712	12 Dec. 55
28	" " " "	2	1,809	446,968	12 Dec. 55
29	" " " "	2	2,533	625,854	12 Dec. 55
30	" " " "	1	16,433	4,060,265	12 Dec. 55
31	" " " "	2	26,324	6,504,134	12 Dec. 55
32	" " " "	1	5,131	1,267,767	12 Dec. 55
33	" " " "	2	26,094	6,447,305	12 Dec. 55
34	BP Exploration (Libya)	1	20,086	4,962,849	28 Jan. 56
35	(British Petroleum)	2	1,829	451,909	28 Jan. 56
36	" " " "	2	5,573	1,376,976	28 Jan. 56
37	" " " "	2	8,842	2,184,681	28 Jan. 56
38	Libyan Shell N. V.	1	6,079	1,501,999	11 Jan. 56
39	" " "	1	6,233	1,540,050	11 Jan. 56
40	" " "	1	4,770	1,178,571	11 Jan. 56
41	" " "	2	16,132	3,985,894	11 Jan. 56
42	American Overseas	1	13,742	3,395,373	31 Dec. 55
43	Petroleum (Caltex)	1	8,258	2,040,386	31 Dec. 55
44	" " "	1	6,885	1,701,146	31 Dec. 55
45	" " "	2	1,809	446,967	31 Dec. 55
46	" " "	2	18,613	4,598,900	31 Dec. 55
47	" " "	2	4,144	1,023,899	31 Dec. 55
48	Esso Standard (Libya) Inc.	4	6,823	1,685,827	2 May 56
49	Compagnie des Petroles Total	4	9,720	2,401,617	2 May 56
50	Mobil Oil of Canada Ltd.	4	19,715	4,871,182	2 May 56
51	American Overseas	2	5,374	1,327,808	2 May 56
52	Libyan Shell	4	4,295	1,061,208	15 Dec. 56
53	Oasis Oil Company	2	1,012	250,045	22 Dec. 56
54	Cancelled June 18, 1957	2	1,439	355,548	22 Dec. 56
55	" " " "	2	1,737	429,178	22 Dec. 56
56	" " " "	2	2,113	522,080	26 Jan. 57
57	Mobil Oil of Canada Ltd.	1	5,576	1,377,718	26 Jan. 57
58	Esso Standard (Libya) Inc.	4	16,838	4,871,577	11 Dec. 56
59	Oasis Oil Company	2	24,399	6,028,505	22 Dec. 56
60	" " "	1	24,850	6,139,938	26 Jan. 57
61	Compagnie des Petroles Total	1	8,584	2,120,935	4 Mar. 57
62	Mobil Oil of Canada, Ltd.	1	1,055	260,669	20 Feb. 57
63	BP Exploration (Libya)	1	7,000	1,729,560	11 Jan. 57
64	" " " "	4	29,096	7,189,039	11 Jan. 57
65	Nelson Bunker Hunt	3	32,944	8,139,803	18 Dec. 57
66	Gulf Oil of Libya	1	29,116	7,189,135	8 Apr. 57
67	" " "	4	41,288	10,194,560	8 Apr. 57
68	" " "	4	5,046	1,245,926	8 Apr. 57
69	Libyan Shell	1	7,837	1,936,366	10 Dec. 57
70	" "	1	5,047	1,247,013	10 Dec. 57
71	Oasis Oil Company	3	60,650	14,985,402	18 Dec. 57
72	Mobil Oil of Canada, Ltd.	3	10,997	2,717,359	18 Dec. 57
73	American Overseas	4	40,442	9,992,409	10 Nov. 57
74	Pan American Libya	3	37,242	9,202,498	17 Mar. 58
	(Christiana Corp. 2.125% overriding royalty)				
75	Cancelled 5-17-59	4	10,950	2,703,526	17 Mar. 58
76	Pan American Libya	4	44,716	11,049,324	17 Mar. 58
77	Deutsche Erdoel AG	4	39,892	9,856,000	14 Aug. 58
	(Wintershall 50%)				
78	Gewerkschaft Elwerath	1	22,176	5,479,246	
79					
80	BP Exploration (Libya) II		13,354	3,299,753	5 Sept. 59
81	" " " " III		49,514	12,229,958	5 Sept. 59

[1] 1 sq. km. = 0.384 sq. mi.

[2] Negotiations would bring Jersey Standard into Libyan American.

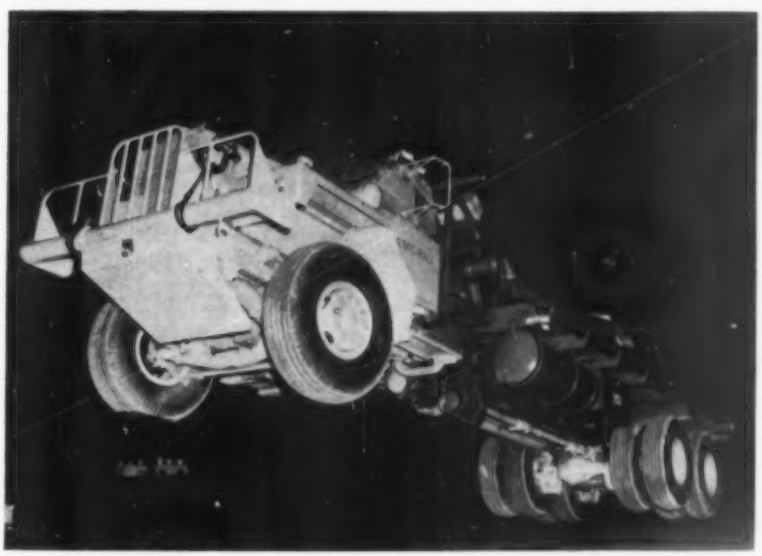
[3] Oasis is wholly owned subsidiary of Ohio Oil, operating concessions owned ⅓ each by Ohio, Amerada, Conoco.

Company Drilling Operations

Esso Standard (Libya) found the largest field in Libya as well as the first one. In April 1959 a wildcat producing 17,500 bbl a day in Libya's Cyrenaica Province was brought in by Esso, opening up a new area in Cyrenaica. Discovery of the well, Zelten No. 1, came after the company had drilled three dry wildcat wells on its Concession No. 6. The well is about 100 miles from the Mediterranean Coast and 200 miles south of Bengasi Production is from a limestone section between 5460-665 ft. The oil is of 37 degree API gravity.

In August Zelten No. 2, about 4½ miles southwest of No. 1, was brought in for 15,000 bbl of 39 API gravity oil.

Esso Libya has also been drilling on another concession in the south of Fezzan Province, near the Algerian border, where numerous oil shows plus a noncommercial oil and gas well were found last year. To date 12 wells have been drilled in the Fezzan without commer-



—Camdrill photo

Big truck is hauled aboard ship to go to Libya for drilling operations. There are now 25 rigs in the oil area that spreads from east to west.

—Texas Gulf Producing photo

Spudding in first well in Libya, the Gerdes El Abid Block 16 in April 1956. This was a dry hole. Libyan American drilled two others before a strike was made.

cial success, and five in Concession No. 6, making a total of 17 wells drilled.

In mid-October three rigs were working in Concession No. 6, one drilling on Zelten No. 3 at about 6200 ft; one drilling at Tedma at about 8600 ft (this rig formerly was working in Concession No. 1), and the third rig was spudding in at Gedaria. Esso has two drilling contractors — Camdrill and Loffland.

Esso has come to an operational agreement recently with Libyan American (Texas Gulf Producing and W. R. Grace), which drilled the first well in the new kingdom. The arrangement, awaiting government approval, is that Esso will match exploration investment already made by Libyan American on Concessions No. 16, 17, and 20, and will become operators. Esso also agrees to buy production from Libyan American.

Oasis Oil Company (subsidiary of Ohio Oil, and operator of concessions owned ⅓ each by Ohio Oil, Amerada, and Continental Oil) has taken an aggressive part in Libyan exploration and has found oil or gas at six sites.

Latest is a wildcat in Concession No. 26 in Western Libya. After getting production at 5719-40 ft and 5699-720 ft on drillstem tests, drilling went ahead to test deeper formations.

The new wildcat is 350 miles west of Concession No. 32 where Oasis made substantial discoveries.

Oasis made the second discovery in June 1958 in Libya at Bahi No. A1 on Block 32, only 75 miles from the coast. The well produced 800 bbl a day from 5822 ft. Five months later the company brought in Dahra No. B1 on the same concession and testing about the same production from 3743 ft.

The company has drilled four oil and two gas wells, all of which are currently shut in.

Libyan-American Oil Company (Texas Gulf Producing-W. R. Grace) spudded in the first exploratory well in April 1956. Conditions and services were rough and the independent operator, Texas Gulf, led the march of drilling crews who withstood heat and wind, supply and service delays. The company has drilled three dry holes on Block 18, one each in 1956, 1957, and 1958. The last one went to 12,000 ft at Farzugha No. 1.

In 1959 Libyan-American hit in Block No. 17 at Mabruk. The wildcat tested 2500 bbl a day. Production was found at 3100, 5711 and 5774 ft. One rig is now drilling at Zahaligh No. 1 on the same concession, and one is drilling on Block No. 20.

American Overseas Oil Company (of Caltex group) has a good discovery at Beda, 132 miles from the coast.

This is Amoseas fifth well with the sixth one drilling five miles north of the Beda well. The company so far has one company-owned rig operating.

One dry hole was drilled in each of Concessions No. 43, 44, and 73.

Libyan Shell, with two drilling rigs in the country, drilled a dry hole in Block No. 52 and a 700 bbl a day discovery in No. 70 at Bir Tlacsin. This went to 13,197 ft total depth before being plugged back. Another site has been spotted north of Tlacsin.

Gulf has one oil producer out of six wells. Emgayet No. A-1 in Concession 66 came in for 888 bbl per day at about 4100 ft. It is 200 miles south of Tripoli. The company is now drilling 14 miles south of the discovery.

Three dry holes were drilled in Concession No. 67 and one in No. 68.

Compagnie des Petroles Total (Libye), a subsidiary of Compagnie Francais des Petroles, in late 1958 found oil in Concession No. 49. Because production has not been developed, the 100 bbl per day the well tested was insufficient to warrant commercial category.

CPT(L) has drilled four wells—two on Concession No. 49 (the first wildcat was dry) and two on No. 23. One on No. 23 had shows of oil and gas.

At present CPT(L)'s two rigs are drilling on Concession No. 24. Compagnie Nouvelle de Forages Petroliers and FORASOL are its drilling contractors.

Mobil Oil of Canada, Ltd. (Socony Mobil) discovered oil 190 miles southeast of Bengasi in October. The wildcat, Amal No. 1, flowed 865 bbl of 34 gravity oil in a preliminary 24-hour production test in the interval between 9841 and 10,405 ft. The discovery well was drilled to a depth of 11,990 ft and plugged back. It is in Block No. 12, totaling about 2,000,000 acres.

This is the easternmost discovery in Libya and is the sixth well that Mobil has drilled in that country. The first five were dry holes, although two of them—El Hafra in Concession No. 11, abandoned August 1958, and El Rakb, abandoned July 1959 — had oil shows.

Mobil now has two rigs of its own in Libya. One of them is drilling 120 miles due west of the discovery, and the second is rigging up to drill 170 miles west of Amal No. 1. The other wells, including the discovery, were drilled by Camdrill International.

BP Exploration Company (Libya) Ltd. (British Petroleum) has drilled three dry holes — in 1958 one each on Blocks No. 63 and 64 and in 1959 another on Block No. 64.

The deepest BP test well in Libya was spudded in mid-October. It will be the first drilled in a BP concession in Cyrenaica, some 120 miles southwest of Tobruk and the same distance from the Egyptian frontier.

BP Exploration waived its right to depletion allowance on both new and old concessions recently when it was granted Blocks 80 and 81. The company also agreed to drill within nine months on one of the two areas.

—Esso Standard photo

Largest discovery so far is Esso Standard's Zelten No. 1 on Concession 6, which tested 17,500 bbl a day. Standing in front of gushing pipes is P. B. Collins of Esso Standard.

Pan American Libya, subsidiary of Pan American International (Standard Indiana) drilled one well on Concession No. 76 in the Fezzan. It was drilled by International Drilling Company.

Nelson Bunker Hunt spudded in the last of October for its first wildcat on Block No. 2. The company is contracting a rig from Penrod Drilling Company brought to Libya from Pakistan.

Geology

Except for the last few years little work has been done on the overall geology of Libya.

There are four major basins, the most productive so far appears to be the one around the Gulf of Sirte where Libyan American, Oasis, Amoseas, Esso, Mobil and CPT(L) have prospective fields. In the north central part, it is called the Sirte Basin. It contains many large structures. The Zelten discovery is on one about 25 miles long and Oasis Bahi field is located on a structure possibly larger than this.

The one in the Fezzan is the Murzuk Basin. It was mapped by the French before World War II as part of the Sahara exploration. Here are Esso's Atshan discovery and CPT (L)'s Tahara find. The structure on which Atshan is situated is six miles wide and about 12 miles long.

Another large basin — unnamed — is in the southeast where applications are overlapping.

Libya is on the northern edge of the African shield. The basins contain thick sequences of Paleozoic rocks; except in northwest Libya the Mesozoic sequence is thin.

In 1958 the Petroleum Exploration Society of Libya was organized with 280 members. One purpose is to aid the U. S. Geological Survey mission in completing a new geological map of Libya. Another is to standardize the stratigraphic nomenclature used in the area.

Exploration Is Intense

"Libya has been the most actively explored area in the shortest time known to modern oil searchers. This huge tractless desert area has, however, merely been scratched. The number of wells drilled to date in Libya is less than a fraction of the wells drilled in many fields in West Texas. At least a dozen new oil-producing areas have been found and dozens more will undoubtedly follow. All of the oil and gas found to this date is high gravity sweet oil. Much gas has been tested." So said Tyler F. Woodward, president of Camdrill International, Inc., which has had a substantial part in Libyan drilling.[2]

More than 65 percent of Libya is covered by concessions. Within five years of the concession date 25 percent must be released to the government. The current frantic effort to explore the concessions is mainly by the companies that have concessions dated November and December 1955. They must relinquish 25 percent at the end of 1960. Another large group of blocks must be evaluated in 1961.

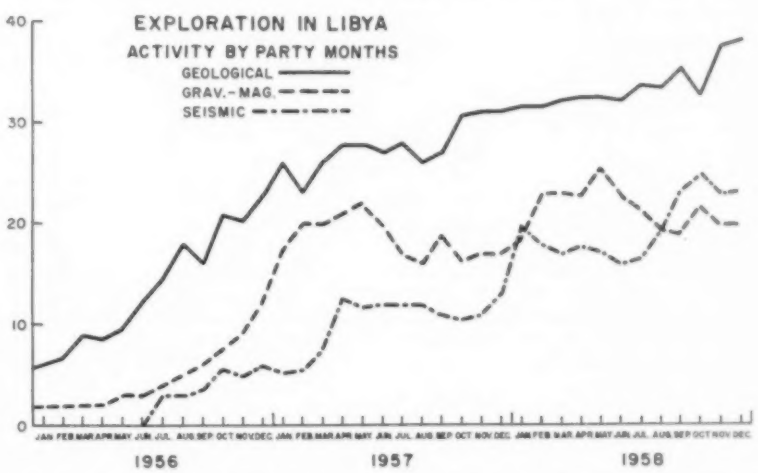
The graph shows the rise in geological and geophysical effort in the last three years. This year exploration work is expected to be more than in 1958.

Dr. Qasem of the Petroleum Commission points out: "Operations moved fast. By the end of 1959 there will be in the field approximately 25 geological parties and 35 seismic crews.[3] Gravity and magnetometer parties, which reached 20 during 1958, will fade away by the end of the year and the beginning of 1960, except, of course, in respect of new concessions that may be granted in the meantime. Exploratory rigs which were only 9 during 1958 will jump to 25 by the end of this year."

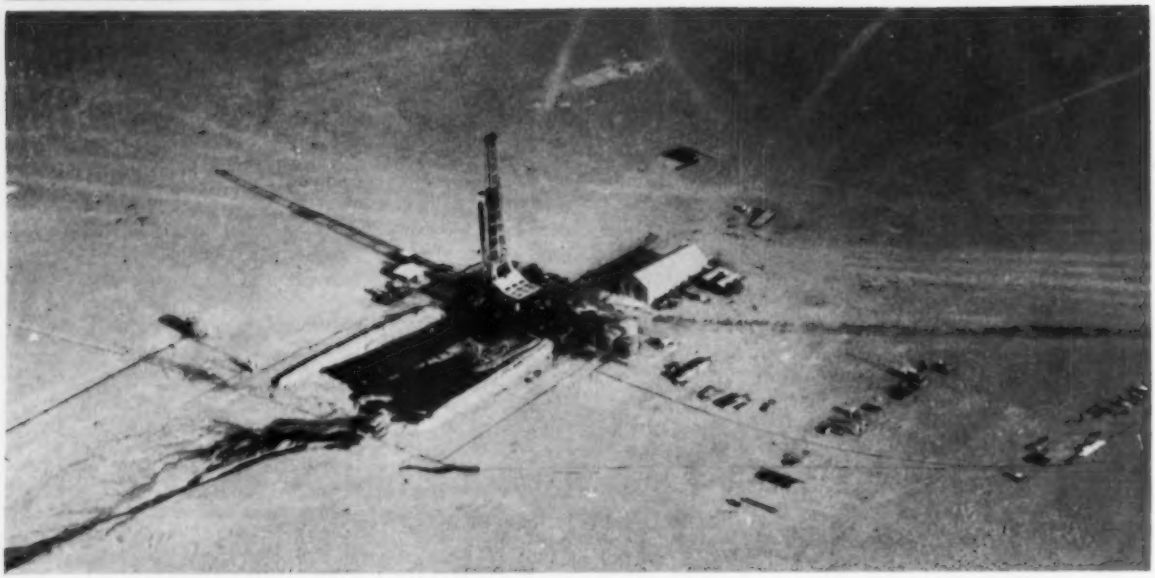
Allan Sawyer, Esso, reported in American Association of Petroleum Geologists Bulletin (July 1959) the following party months for 1958 for 12 companies:

	Party months
Surface geology	**407**
Seismic	**233**
Gravity	**253**
Ground magnetics	**66**
Air magnetics	**6**
Structure drilling	**24**
Mine clearance	**569**
TOTAL	**1558**

[2]See *The Petroleum Engineer* for January 1959, "Desert Star Is Libya Bound," Page B-56.
[3]Later information is that 37 or 38 seismic parties are in Libya.



This graph shows how exploration activity has increased. Reports for 1959 indicate still greater activity for the year.



—Shell photo

At this spot, Libyan Shell drilled the deepest well to date at Bir Tlacsin, on Concession 70. Total depth was 13,197 ft. The well was plugged back to 8884-980 ft and brought in for 700 bbl a day. The company is now drilling to the north of here.

A footnote explains the table does not include precise level, astrofix, baseline surveys, or water-well drilling.

Mine Clearance

The list shows mine clearance is an essential part of exploration in Libya. A Jersey Standard release concerning Zelten No. 1 stated:

"In Cyrenaica and Tripolitania, the coastal provinces, exploration was complicated by thousands of uncharted and hidden mine fields left by Allied and Axis armies which battled there for control of North Africa and the Middle East during World War II. Mine detector crews have been constantly in Cyrenaica and Tripolitania to clear roadways for bringing in trucks, housing and equipment. Careful training and the hiring of demolition experts have made it possible to operate without casualties from this always potentially dangerous source."

A description of mine clearance activities in *The Beacon* (Ohio Oil Company magazine) relates Oasis's experience. The firm's mine clearance department is headed by an ex-Army officer who hired former German Army officers for supervisors. The crews are Libyan nationals trained for the work.

The article explains: "Both helicopters and airplanes are used extensively by Oasis for mine clearance work. Landing a helicopter in an uncleared area is an involved process. The detector operator sits on the floor of the 'copter, his feet out the door on a step. The resonator, tuned to a high pitch, is held against his ear so he can hear it above the noise of the engine. The helicopter hovers just over the ground while the operator sweeps over a small spot to see if it is clear. If it is, he steps out. The 'copter then flies off and the operator clears an area five meters square. The helicopter returns and lands in the cleared area, which is later marked with dirt, rocks, flags or lime for further use."

The *Flying Red Horse* (Socony Mobil magazine) reported: "Mine-clearing teams working for oil companies have practiced a unique form of community relations among the Libyan people: They have cleared many areas around—and in—villages, where the people have lived in constant danger of sudden death for more than a decade. They have discovered anti-personnel mines under village streets, anti-tank mines around water wells, and devilish 'bouncing Betties'—which leap out of the earth and explode in mid-air — in schoolyards."

Another costly feature is finding water. It isn't easy. Spudding in has been delayed more than once by difficulty in locating a water supply for the rotary rig.

For instance, Libyan American has one drilling rig each on Blocks 17 and 20. It also has two water well rigs — one on No. 16 and another on No. 20.

David Schaffnit, Nelson Bunker Hunt, said the drilling on Hunt's No. 2 Concession was held up by efforts to find water.

Offshore exploration is forecast since Geophysical Service Inc. is moving its motor vessel, SONIC, a single-ship marine seismic operation, from the Persian Gulf into the Mediterranean.

Economics

This is expensive exploration. Sums are risked which would never have been budgeted for Libya without the 50-50 petroleum law of 1955.

The Petroleum Commission[4] published the following data on reported annual expenditures in Libya:

1956	**$13,000,000**
1957	**38,000,000**
1958	**67,000,000**
1959 est	**84,000,000**
Approx. total	**$202,000,000**

Exploration costs are on the extremely high level — two to three times what they are in the United States. The desert heat makes air conditioning essential for men and instruments. To quote Tyler F. Woodward, Camdrill, again: "The logistics of oil exploration in Libya are tremendous. Men and machines suffer from the extremities of heat and cold, as well as from wind and dust. Most people think of the Sahara as an inferno of heat and sand; however, it can be as cold as it can be hot, and it also can be a beautiful heaven of stars, moon and colors at varying times of each day and of the seasons."

Rivers of wind-blown sand give

[4] "Petroleum Development in Libya, 1954 Through 1958" published by Petroleum Commission, P. O. Box 225, Sciara al Kahira 22, Benghazi, or: P. O. Box 256, Federal Government Compound, Sciara Adrian Pelt, Tripoli.

British Petroleum photo

BP Exploration crew drills for water which is scarce in Libya. Much of Libya is still unmapped. There are impassable sand seas, tangles of sand dunes, almost inaccessible hills and great salt flats.

Shell photo

Aerial view of a Shell Exploration Company seismic party camp during a survey for possible oil-bearing locations in Concession No. 52 in the Fezzan province. This concession area is situated deep in the Sahara, three hours flying time from Tripoli and 150 miles from the nearest oasis.

trucks real trouble. The trucks sink in and have to be manipulated inch by inch across the barrier. Both machines and men suffer.

Range in drilling costs are fairly wide at present because most wells are wildcats and every one is a special problem. So far, they probably average over $700,000 per well.

Initial concession payments are nominal and so are rentals. But once a field is declared a commercial area rents go up to £ L2500 ($7025.00) per square kilometer. This figures about $28.67 per acre annually.

E. C. Borrego, vice president of Libyan American, said simply, "It takes a lot of money."

Will it pay out? A lot of chips say it will.

People and Public

We have read reports that the atmosphere in Libya was cooling toward foreigners — that inflation, misunderstandings, U. S. air bases, had stirred up antagonism toward oil companies and their personnel. Oil people who have been there for their companies say it simply isn't true. There is, they say, strong cooperation between Libyans and industry.

It's a new nation and there is, as we mentioned, some strong province feeling. There are two capitals — you'll note — the only way agreement could be made on union. There's Tripoli in Tripolitania and Bengasi* in Cyrenaica. The only other province, Fezzan, is so thinly populated the people evidently didn't put in a bid for the third one. This provincial loyalty calls for careful bookkeeping when materials are hauled from one province to another.

There's also a loyal faith that Libyans can do anything and a desire to see a Libyan at the driller's or toolpusher's job whether he knows anything about drilling or not.

A man from one of the independents says, "We're teaching them as fast as we can and holding off the amateurs."

Dr. Mohieddine Fedini, Libya's ambassador to the United States and United Nations representative, said in Texas recently that oil income would provide much needed education. He stated that 95 percent of his country's 1,300,000 people were illiterate. (The 1959 World Almanac says of the million nomadic Arab Moslems of Libya about 40 percent are literate.)

The country is certainly one of the poorest in the world. The government has required heavy subsidies from the United States (about $100 million) and Great Britain (about $70 million) in the last eight years. Imagine the impact of $84 million investment by oil companies in one year! It may reduce the need for outside aid.

The belief that oil companies and the Libyan government and public were getting along pretty well together was expressed time and again by oil men and by government officials.

"We have been working in Libya since 1954 and have found the Libyan people to be hard working, intelligent and anxious to contribute to the development of their new country. We have found the government to be cooperative and sympathetic to our problems," said H. W. Brown, executive vice president of Esso Libya.

Said a drilling contractor, "Libya is changing rapidly and its small able-bodied population is getting experience in a fast-moving way. They will succeed, too."

The Petroleum Commission released these figures for number of persons employed by the petroleum industry:

	Libyans	Total
1956	1,150	1,550 persons
1957	2,900	4,050 persons
1958	4,600	6,400 persons

As the commission reported: "Libyans are learning new and diversified skills and as rapidly as possible being placed in positions of responsibility . . . In addition to those directly engaged in petroleum exploration, there is hardly a single resident of Libya not affected to some measure by exploration effort."

The Future

When Atshan first blew in, there was much speculation about a pipeline from the Fezzan to the coast at Tripoli, some 400 to 500 miles.

Now engineering and hydrographic work is proceeding on two possible pipelines from fields in the Sirte Basin to the coast.

One would transport Zelten area production almost straight north, where a large port would be built. The other would carry output from Oasis and Libyan American fields northeast

* Sometimes spelled Benghazi.

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Tripoli: Box 682. Tel: 557. WESBOURDO. Wesley E. Bourdo, mgr.

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Tripoli: Box 634. FOREX. Aubin N. Griffith, mgr.

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Benghazi: Box 220.

SCHLUMBERGER OVERSEAS, S. A. (well surveying, logging)
Tripoli: Box 606. Tel: 6388. SCHLUMBERGER POB 606. Marcel Delessert, mgr.

UNITED GEOPHYSICAL CO. (seismograph, gravity meter, magnetometer surveys)
Tripoli: Box 68. Tel: 5415. UNITEDGEO. F. W. Perrin, supervisor.

to another port. This would also be practically all new construction.

The Zelten field is about 100 miles south of the coastline and estimate of cost of pipeline is around $50 million. This will depend upon size of the line and many other factors. The 24-in. pipeline built by the French from the Algerian Sahara 400 miles to the coast at Bougie is said to have cost $100 million.

Of course, Libyan production in volume is not proved but there is high optimism. Most wildcats have had shows of oil and gas, whether commercial or not. There is great variety in producing strata and quality of oil has been consistently high.

Only prediction of reserves we've heard was 50 billion bbl. This is Middle East size. It is a figure to refer to about 1970. Impossible even to speculate about now.

Construction of an oil refinery at Bengasi is also being considered, reported the Petroleum Commission of Libya in October 1959.

Who will buy the oil? Best and most logical market is Europe, now supplied principally by Middle East crude oil.

There is speculation that Libya (and Algeria) will be in a position to take the markets from Middle East producers because they are closer. Transportation cost is estimated to be 60 to 80 cents a bbl less from North Africa. Rise in European crude imports, however, may be strong enough to absorb the extra output. Imports to West Europe the first half of 1959 were 18 percent higher than in the 1958 period.

Natural gas reserves also appear to be large enough to attract transportation capital. This could mean a pipeline on the seabed of the Mediterranean to transport the gas.

Director of Petroleum Affairs, A. Hogenhuis, states: "Fuel consumption in Libya is presently comparatively small—about 2000 bbl a day. However, history and experience show that the discovery of oil in any country brings with it a greater demand for petroleum products.[5]"

He adds, "Libya is certainly taking its place among the countries of great potentialities. However, only time and hard work will show how far such a good promise will be fulfilled."

The future looks bright — both for the kingdom and for the industry. As the Libyan Petroleum Commission said:

"Libya is young and in the early phase of oil exploration, but it is the hope and prayers of all engaged, Libyans and non-Libyans, that the future will hear of success in Libya."

[5]One oil company executive thought 2000 bbl a day much too low an estimate. Perhaps Director Hogenhuis' observation is already in process and greater demand is already there. ★

HOW TO BE A MANAGER

Human Relations

William E. Bright, Jr.

"No race can prosper until it learns that there is as much dignity in tilling a field as in writing a poem." — Booker T. Washington

FEW TERMS CAN MATCH "human relations" in getting a wide variety of reactions among business people. It may also be significant that many of these reactions contain as much emotion as logic. Let us begin, therefore, by saying what "human relations" means in our context, and by taking a relatively non-emotional approach to the subject. Let us define human relations as: A body of theory and practice used to achieve work relationships that are productive, satisfying and growth-inducing for most members of a business organization . . . and hence for the whole organization itself.

For our purpose the term cannot imply a management philosophy compounded of equal parts of "sweetness and light." Anyone who has served as a manager — or as a parent — will recognize that maintaining good human relationships entails more than just being kind and understanding. There are many differences, of course, between the manager-employee relationship and that between parent and child. The absence of firm and consistent discipline, however, will "spoil" employees as well as children.

Along the way we shall consider four main questions:

1. *Why has it become popular to debunk* HUMAN RELATIONS?
2. *What basic elements in* HUMAN RELATIONS *have demonstrated their worth?*
3. *Why do some managers fail to achieve good* HUMAN RELATIONS?
4. *What is the future of* HUMAN RELATIONS *in business and industry?*

William E. Bright, Jr., *is manager of employee development, The Pure Oil Company, Chicago, Illinois. He has been with Pure since 1939 and has had experience in sales supervisory training, employee and management development in the company.*

He received his AB degree in 1936 from Brown University, and later studied at Northwestern and Chicago Universities in semantics, communications, human relations, and adult education. He attended Northwestern University Institute for Management in 1952.

At Lake Forest College he was on the faculty for Industrial Management Institute and at Dartmouth College he taught at the Graduate School of Credit and Financial Management. He is on the advisory board of the American School and of the Institute of Social and Industrial Relations of Loyola University. One of his several memberships is National Industrial Conference Board, where he serves on advisory council on development, education and training.

Fadism hasn't helped human relations.

WHY ALL THE DEBUNKING?

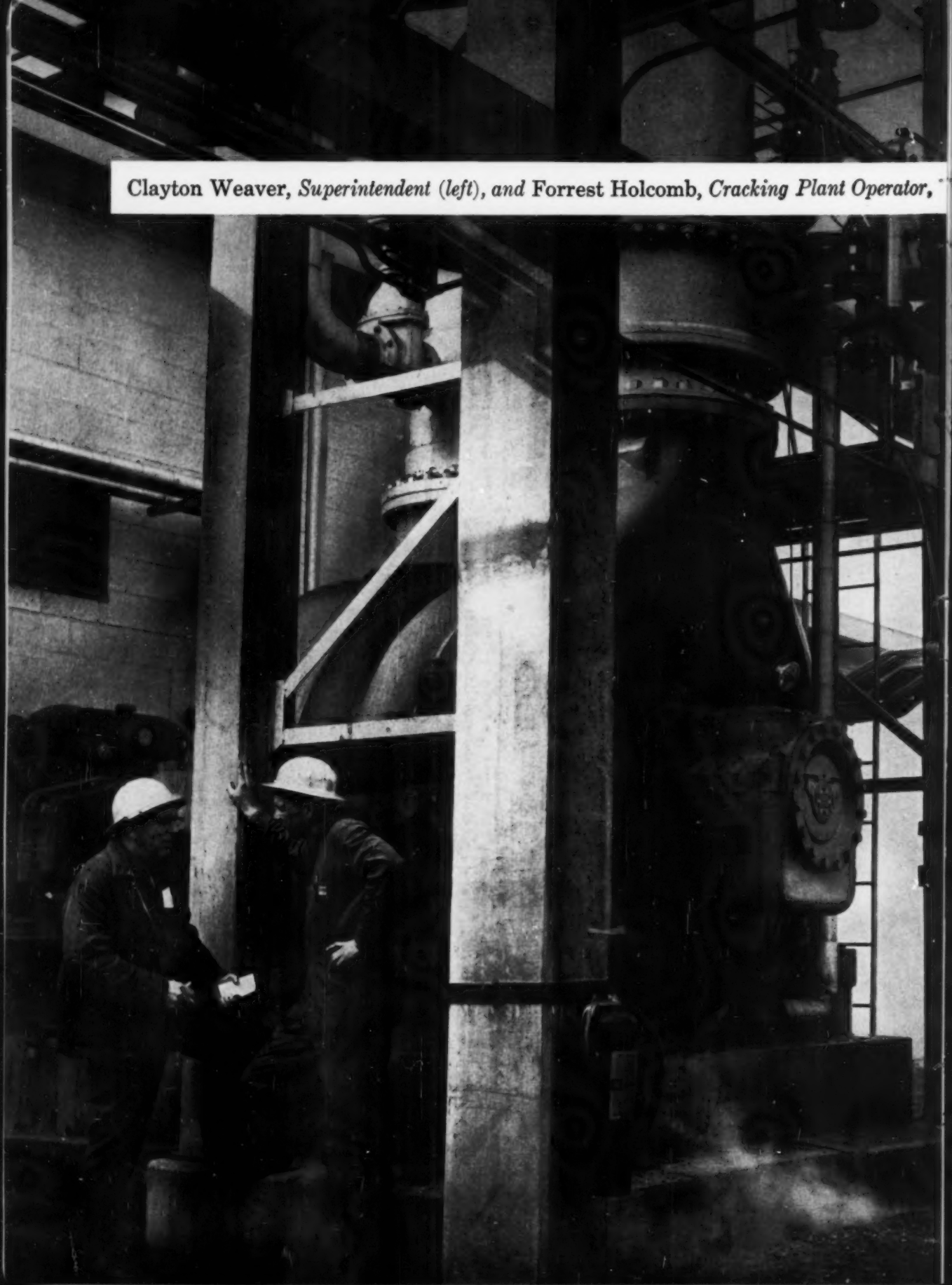
There is nothing new about debunking human relations. The critical flurry of the late 1950's seems mild when compared with some earlier attacks. There have always been business leaders who say the way to manage men is to pay them well, be firm and supervise them closely. If we reflect, however, it is possible to see some other reasons why industry's practice of human relations has invited debunking.

First among these is **fadism.** All who have worshipped at the shrine of the efficiency expert, economic educator and systems analyst must grant industry's flair for fads. Nowhere, except perhaps in women's fashions, is the cult of the moment more faithfully practiced. In the past decade many a company president has returned from an industry conference to announce: "What our people need is a program on human relations."

Sometimes, of course, this was true and the results beneficial. Programs based largely upon a desire to be fashionable, however, tended to wither quickly. They became fair game for the debunker, who then cleared the way for the next fad or fashion.

Many human relations projects in business have failed for **lack of example-setting support from top management.** All too often an executive has considered human relations of value just for his subordinates in their relationship with the rank and file of the organization. No pattern of work relationships will survive at lower levels in an organization when contradicted daily by executive behavior. The supervisor generally treats his employees about the same way his superiors treat him. Nothing could be more natural.

More than for any other reason human relations is deplored because some exclusively egocentric and power-oriented **people misuse it.** This is like blaming the rope used to hang an innocent man. When a manager's personal ambition outweighs his regard for the rights of others he tends to:



Clayton Weaver, *Superintendent (left), and* Forrest Holcomb, *Cracking Plant Operator,*

Leonard Refineries, discuss function of air supply in catalytic cracking and...

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1. . . . *view* HUMAN RELATIONS *as a complex of mechanical techniques,*
2. . . . *use these techniques to manipulate others for his own benefit.*

Sometime he is sincere, having reasoned that what is good for him is always best for others. At other times he is simply amoral; he defines ethics as whatever serves his own purposes. In either case he does great harm, not just to the reputation of human relations but to his organization as well. His actions, like those of a political dictator, breed frustration and dependency among his subordinates. The team he leads is a "house of cards." When he falls, there is no one to take his place. It is unfortunate that he is so often one who seizes every occasion to profess eloquently his belief in human relations.

There are many reasons, then, why the debunker has found human relations an inviting target. Are there elements in this discipline that can withstand his ridicule?

WHAT HAS HUMAN RELATIONS TAUGHT?

From human relations and the behavioral sciences industry has acquired the idea that it is profitable to create a work environment in which the employee may satisfy certain psychological needs we all share. This is quite a departure from the old concept of the "economic man," who is motivated largely by money as an end in itself. It goes far beyond recognizing the physiological needs, which has so greatly improved physical working conditions in the typical plant. It suggests that, given reasonably adequate wages and working conditions, *an employee's psychological needs determine his behavior.*

At first this was interpreted to mean that if employees are happy and contented they will also be more productive. Experience soon indicated, however, that the "contented producer" theorem works less well with employees than with cows. A more appealing idea has now taken its place.

When an employee's wages and working conditions are adequate, he begins to respond to other needs.

He begins to want a sense of belonging to the organization he serves.

He wants recognition for the good work he performs.

He also may become quite concerned with his relative status in the organization.

He needs to continue emotional and intellectual growth, and to do creative work.

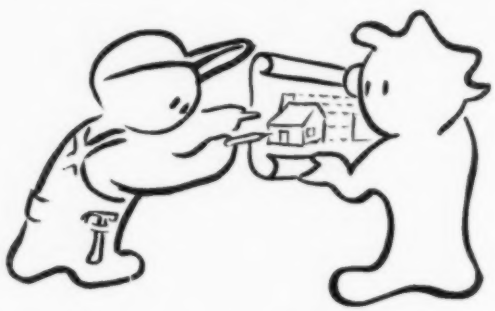
Generally speaking, it is only when his basic drives are frustrated or blocked that the employee acts against the interests of his organization. When these needs are taken into account it becomes economically wise for the business organization to create a work environment in which the employee may achieve psychological satisfaction.

With the employee's basic human drives in mind certain managerial attitudes, policies and practices become significant.

Where automation cannot be used to transfer unchallenging or repetitive work from people to machines you can enlarge an employee's job, or rotate him among several different jobs. Experience indicates that either action will interest and challenge him to better performance. Among managers and supervisors authority can be delegated to spread the opportunity for them to serve the organization's best interests while responding to the basic needs they feel. Young men are thus able to learn decision-making, by making decisions; and at this stage the inevitable mistakes are not too costly.

Assigning the employee to special work projects, temporary committees or to university or company training programs will often improve his performance and development.

The study of human relations has also tended to improve the typical company's communication with its public, customers, stockholders and employees. In some cases, today, this communication is of high calibre. It does not just supply information but creates understanding by relating this information to the company's objectives. Occasionally



The man under you can feedback ideas.

it even takes the form of two-way communication. Then the company can discover what a message really means to its audience. Often a company can pick up useful ideas and information through the "feedback" process.

Still another practice that human relations has helped to foster is called "consultative supervision." To use it a manager simply consults with his subordinates before making his decisions. He does not escape being accountable for his decisions, nor does he give up any part of making them. But whenever practicable he seeks advice from those who report to him. When his decision contradicts the advice he has received he explains why this has occurred. Used with discretion consultative supervision has seemed to enhance the manager's authority and improve the performance of his subordinates.

More important than its introduction of specific managerial practices is the impact human relations has had upon a company's attitude toward the employee.

Despite the furor over "the organization man" a typical business organization today tolerates non-conformity much more than was the case fifty years ago. Then the employee, who often worked seven twelve-hour days each week, conformed precisely to a rigid company discipline, or was dismissed without notice. By contrast many non-conformist employees are happily doing creative work today in some of the largest business organizations.

Every year more business leaders give up the Old World

Basic drives must be unblocked.

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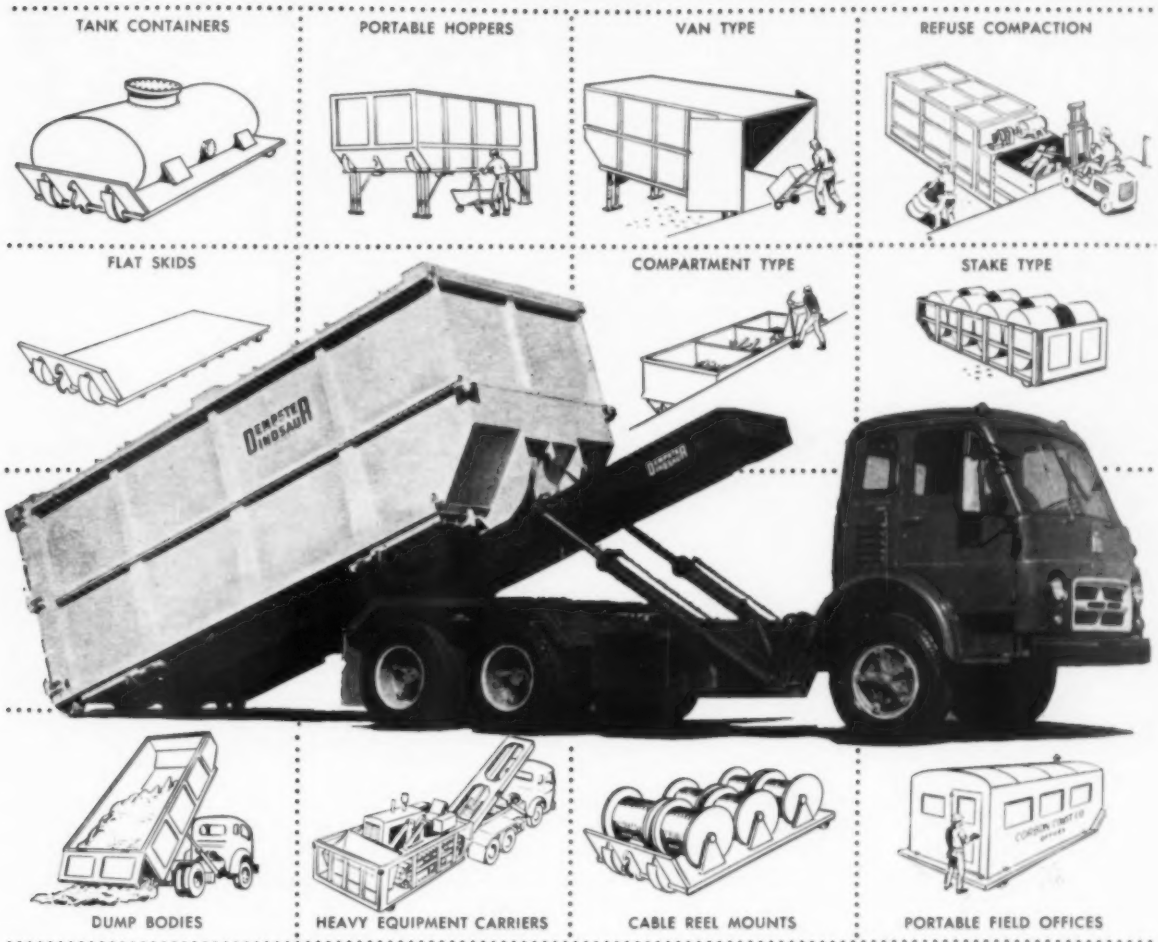

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notion that an employee should be considered guilty of dishonesty and laziness until he is proved innocent by somehow becoming a manager. Today, most of the larger and more successful companies operate on the basis of three fundamental assumptions regarding their employees:

1. **By-and-large employees are honest.**
2. **They want to do good work.**
3. **It is profitable to respect human dignity and the rights of the individual.**

There will always be exceptions to any such generalization; and irresponsible labor leaders have also greatly complicated the problems of industrial relations. Granting these exceptions, however, the generalization still contains much truth. If human relations had made no other lasting contribution to management philosophy it would still have been immensely worthwhile.

WHY SOME MANAGERS FAIL

If human relations has demonstrated its worth, why do some managers still fail to use its concepts for the benefit of all concerned? This question has often been answered by saying that the stupid and unprincipled shall always be with us. Such an answer, however, has no remedial value. It may be constructive to consider some of the more specific sources of the dilemma.

For instance, there is the "no time for such nonsense" fallacy. Some managers feel driven to do more work than

Why not delegate some work?

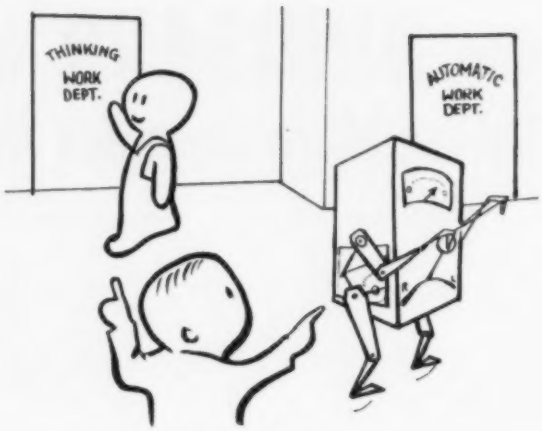
a twenty-hour day will contain. Sadly, they have no time to delegate or develop the teamwork that would ultimately ease their burdens.

Occasionally a top executive knows himself to be more competent than any of his subordinates in all phases of their work. Then the temptation not to delegate is strong. And if he doesn't delegate no one below him can delegate either. He will demand they keep as tight control over the details of their work as he does over his.

It would be unrealistic to claim that all managers are considerate of others' rights and needs. Given the human propensity for rationalizing, however, it seems likely that many non-productive human relationships are maintained with the best of good intentions. And in fairness to the manager, we must admit that some organizational environments greatly over-emphasize individual competitiveness. When this occurs the law of the jungle is likely to prevail.

WHAT OF THE FUTURE?

What, then, is the future of human relations in the business environment? The historical perspective is important. The concepts of human relations helped to create a great



Let machine do boring work —
man enjoy the challenging projects.

change in the thinking of industrial leaders during the past century. An optimist may be content to assume that established trends will continue. To the pessimist is left the familiar recourse of focusing upon exceptions. Certain trends occurring in our total economic and social environment may serve to strengthen the optimistic view.

Technological advance tends to reduce industrial frustration. It frees man for more challenging and rewarding work.

By definition the median member of a culture becomes more civilized as his culture advances. Mass communication increases in variety and volume. We can hardly avoid becoming at least more conscious of basic human needs and rights we all share.

If we manage to survive at all the chances are good that we shall learn to improve still further our relations with each other.

Human relations in business is just one aspect of this total advance. Employees, today, could not be treated as employees were treated one hundred years ago. Who really doubts that in the next hundred years further changes along the same trend-lines will occur?

A PERSONAL PERSPECTIVE

To this point we have discussed the past, present and future of human relations in business from an analytical viewpoint. Doing so tends to present the subject in general terms. But human relations is very much a personal matter. Practicing it deeply involves one's individual beliefs. If we are to understand what human relations really means we must also assume a personal perspective.

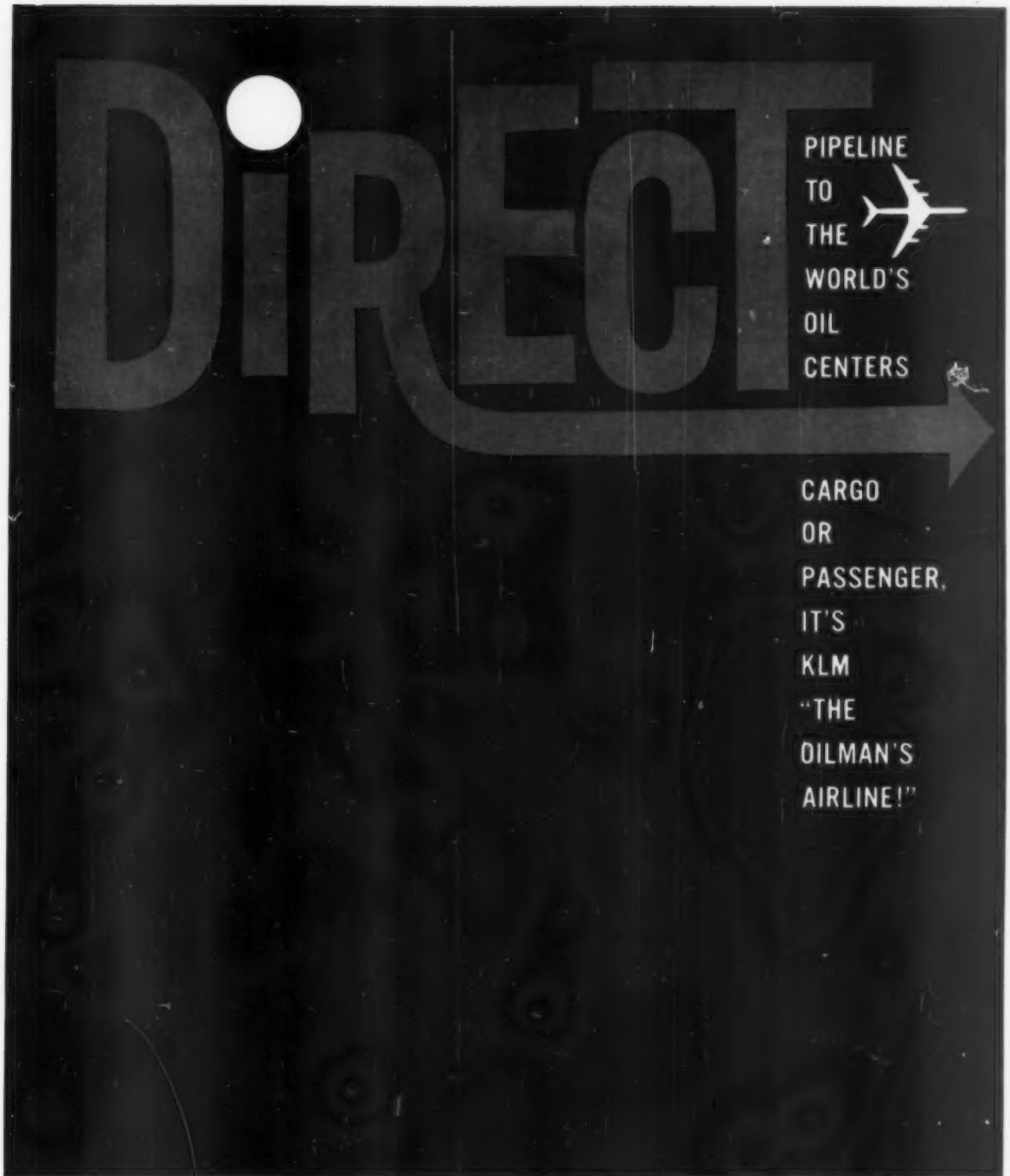
Let us consider now what one successful business executive, R. L. Milligan, president of The Pure Oil Company, has to say about the beliefs that have helped him build a satisfying career in the oil industry. The following passages are excerpted from a letter Mr. Milligan wrote in December 1958, to a student who was doing research for a term paper.

1. MY PERSONAL PHILOSOPHY.

In order to have a satisfying and happy career in a corporation I believe —

One must have a willingness to exert himself toward influencing the action of others and receive a personal satisfaction from accomplishing results through others as well as directly through himself.

In working inside the Company, more than outside,



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toward the development of character, attitude and spirit in our organization.

In encouraging satisfaction from accomplishment and that one should demonstrate appreciation as to results accomplished.

Above all one must preserve his own self-respect at all costs and there must be complete integrity and honesty in all relations.

In a willingness to pioneer without the less desirable aspects of crusading.

With the slogan "Live and Let Live" I believe that one should not be unduly curious as to the private affairs of others and should be considerate of the rights and feelings of others.

I believe that modesty is a virtue. I also believe that one must have a recognition of spiritual values rather than only the materialistic approach.

I do not believe in the "Ivory Tower" type of executive but that as much as possible one should consult and confer with others in arriving at decisions yet preserving virility in policies — not merely compromises such as encouraged by the committee type of management.

2. MY BUSINESS PHILOSOPHY.

I believe —

A corporation must preserve the highest degree of integrity in quality of products, services and dealings, and always be in a position of being able to go back to make another deal.

In the recognition of the individuality of each employee and the providing of safe and agreeable working conditions, a high degree of mechanical aids, incentives and reasonable remuneration, aids in education and training, and the creation of an atmosphere of "belonging to the team" under which employees are advised currently as to company developments and encouraged to participate in considerations leading to policy decisions.

An atmosphere of confidence is most necessary in a company whereby the employees may have complete confidence in the management of the company.

The company should refrain from propagandizing employees. There should be encouragement for the employees to participate in community, industry, professional and political activities. The company should endeavor to create a favorable attitude on the part of the employees whereby they properly reflect the company and not reflect upon the company. A wholesome atmosphere should be maintained, thus creating a desire for cooperation and teamwork.

3. CHARACTERISTICS NEEDED IN MANAGEMENT.

In selecting people for positions in management —

Aside from the usual factors of education, experience and aptitudes, I look for, above all, a demonstration of sincerity.

I value highly pleasing personality factors, appearance, an industrious disposition and a personal driving force, and the demonstration of perseverance with a willingness to fight against adverse odds.

The individual must demonstrate a high degree of integrity, intelligence, imagination, regularity and temperance in habits and favorable attitudes, with willingness to cooperate. He must demonstrate that he has the proper philosophy with respect to working in a corporation — that he may be influenced as much from a sense of accomplishment as by remuneration, and that he is willing to exert himself toward influencing the action of others rather than "being a lone wolf." He must be alert, aggressive and progressive and have a burning desire to get ahead.

4. TO WHAT DO I ATTRIBUTE MY SUCCESS?

I believe that it is important —

To think in terms of the company or industry over-all, rather than as to divisions or departments.

To have a keen desire to know more and more about more and more, rather than about less and less. In other words to have developed broad understanding and sympathies. Perseverance and determination with intense application have also been important.

To have a desire for understanding the different personalities of associates which has been a help in picking aides.

To have courage in decision making and in making changes in personnel after careful consideration and review of the factors involved.

To take nothing for granted — in other words not to be too tied to conventional thinking.

To analyse and plan ahead with imagination.

To have a natural liking of people and the pleasure derived from working with people — wanting to build an organization rather than one's self.

There you have it — Human Relations from both the general and personal perspectives. It has been wisely said that "an orator is a good man speaking well." There is nothing more important to remember when you set out to practice good human relations.

Points for You to Check

1. How much of human relations is merely a fad?
2. Why is executive behavior so important in work relations?
3. Why are some middle managers afraid to delegate?
4. What basic satisfactions do people seek in their work?
5. Is automation a threat or an aid to maintaining good morale?
6. Does a manager lose face when he asks his subordinates for advice?
7. What basic assumptions do many successful companies make about their employees?

Try Some Extra Reading

[1]*Allport, Floyd H., "Social Psychology." Boston: Houghton Mifflin, 1924.*

[2]*Brown, J. A. C., "The Social Psychology of Industry." Baltimore, Md.: Pelican - Penguin Books, 1954.*

[3]*Cantor, Nathaniel, "The Dynamics of Learning." Buffalo: Foster and Stewart, 1946.*

[4]*Glover and Hower, "The Administrator." Homewood, Ill.: R. D. Irwin, Inc., 3rd ed., 1957.*

[5]*Haiman, F. S., "Group Leadership and Democratic Action." Boston: Houghton Mifflin, 1951.*

[6]*Homans, George C., "The Human Group," New York: Harcourt, 1950.*

[7]*Maslow, A. H., "Motivation and Personality." New York: Harper, 1954.*

[8]*McGregor, Douglas, "Conditions of Effective Leadership in the Industrial Organization," Journal of Consulting Psychology, VIII (1944), pp. 55-63.*

[9]*Rasey, M. I., "This Is Teaching." New York: Harper, 1950.*

[10]*Rogers, Carl R., "Counselling and Psychotherapy." Boston: Houghton Mifflin, 1942.*

[11]*Snygg and Combs, "Individual Behavior." New York: Harper, 1949.*

[12]*Tead, Ordway, "The Art of Leadership." New York: McGraw Hill, 1935.*

[13]*Viteles, M. S., "Motivation and Morale in Industry." New York: W. W. Norton and Company, 1953.*

[14]*Whitehead, T. N., "Leadership in a Free Society." Cambridge, Mass.: Harvard University Press, 1936.*

Photographed in the Trianon Room, Sheraton East Hotel, New York, N. Y.

The oilman: big hit in this year's fashion show.

Your wife might be surprised to know just how important your industry is to American women. You and oil helped develop oil-based synthetic fabrics dainty as lace, tough as overalls. Oil-based synthetic dyes that challenge the rainbow. Oil-based treatments that put new life into natural fabrics. The next time you hear somebody start to talk against the oil industry, tell him you're an oilman—and proud of it. And tell him why.

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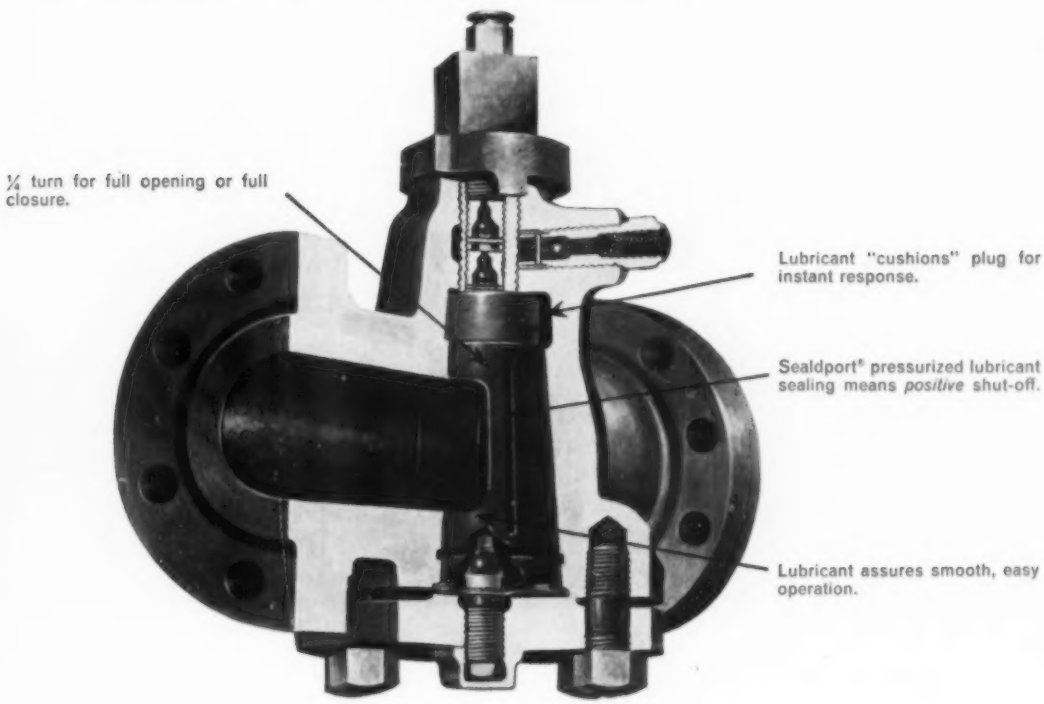
Where control is vital

It isn't just speed and power that wins races . . . it's *control* that makes consistent winners.

It's the same with valves. Valves that are awkward or slow to operate may "lose the race" against impending disaster or costly flow control errors. That's why, wherever flow control must be instantly responsive, you'll see Rockwell-Nordstrom lubricated plug valves. Their *quarter-turn* lubricated closure means perfect control *every time*. The drawing below shows why these valves are so often demanded for the flow control jobs where errors can't be tolerated . . . and why they make flow control foolproof on every service.

PERFECT, FOOLPROOF VALVE OPERATION


¼ turn for full opening or full closure.
Lubricant "cushions" plug for instant response.
Sealdport® pressurized lubricant sealing means *positive* shut-off.
Lubricant assures smooth, easy operation.

Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves with sizes from ¾" to 36" and pressures to 15,000 lb. Available at leading oil field and industrial supply houses everywhere. For details, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. If you live outside the U. S. A., write: Rockwell International Division, Pittsburgh 8, Pa.

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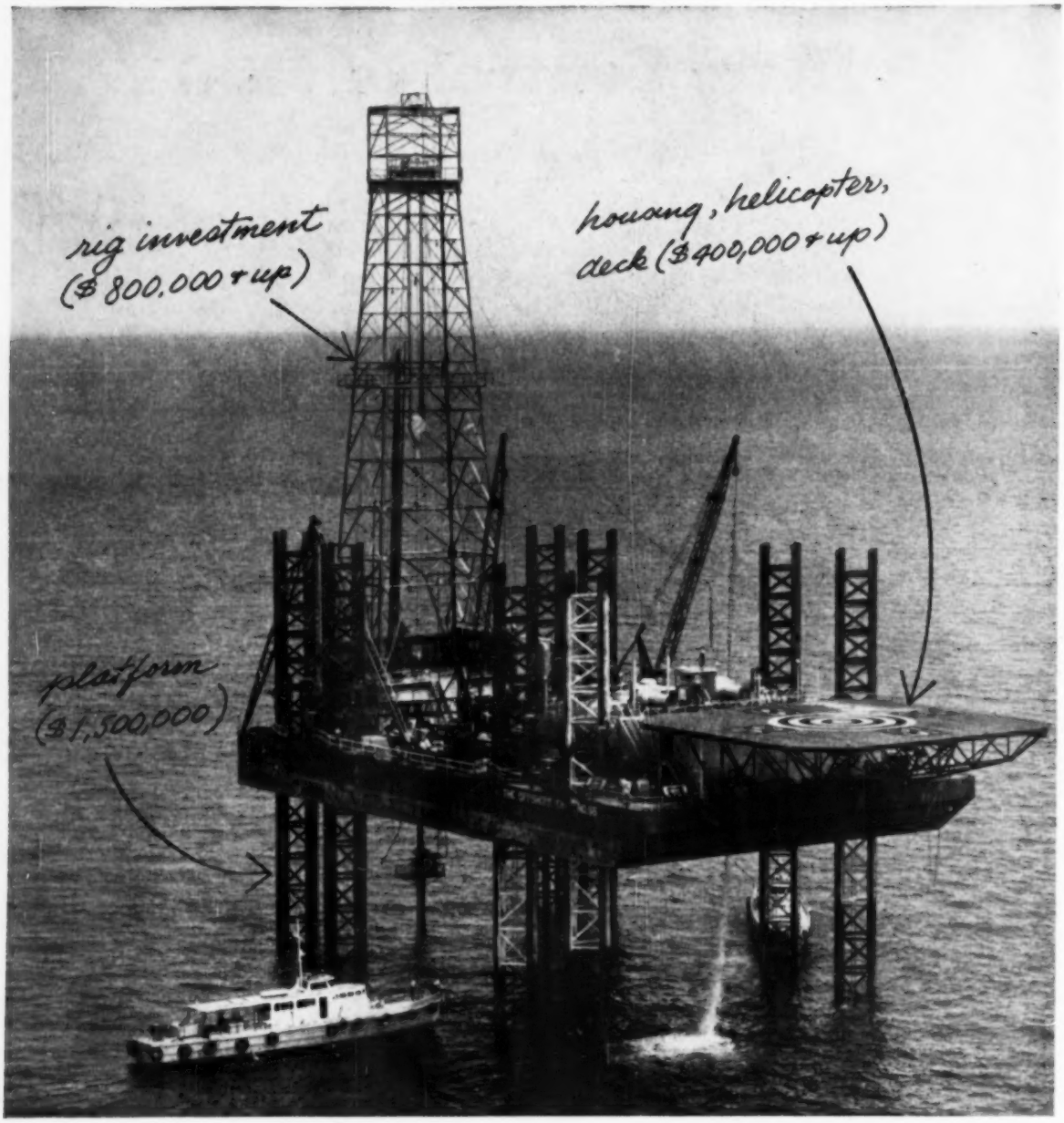
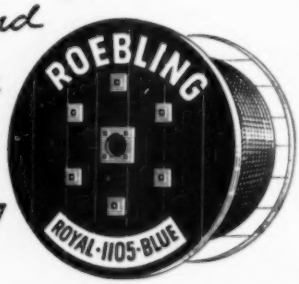


When you spend $4,000,000 for an offshore rig you can't afford not to use the best rope



You wouldn't use Bargain Basement bits. You'd get the best. You'd get the best of everything; that's why an offshore rig can run as much as $4,000,000.

To settle for anything less than Royal Blue at this stage would, indeed, be "pound foolish." For Roebling Royal Blue Wire Rope represents in *its* field, the finest there is.

It is made from the toughest rope wire ever produced—Type 1105—extra high-strength improved plow steel. Royal Blue has all the hard-working advantages of preformed construction; outstanding resistance to abrasion, fatigue, impact, crushing and shock; exceptional flexibility and ruggedness. Collectively, these values add up to 15% more strength than in any other rope you have ever used.

Anything less than Royal Blue can cost you *more*. Your distributor has Royal Blue right now. Get it now and save and save and save. For information on Royal Blue, write Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, N. J.

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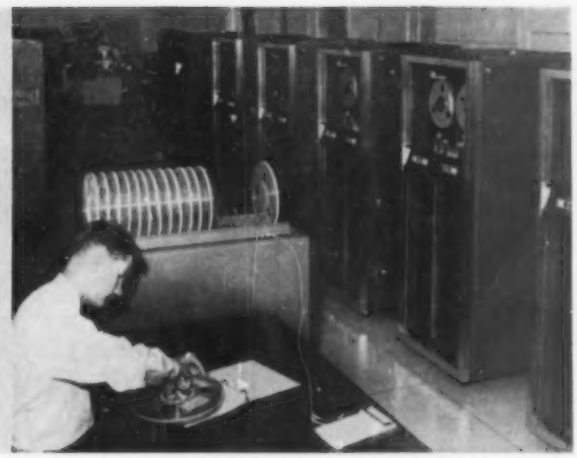


Mobil Oil's newest and largest computer center located in Dallas, Texas, in a specially designed 4000-sq-ft air conditioned room, was recently placed in operation after two years of training for 17 specialists. Cost: $43,700 per month rental.

Mobil Oil Sets Up Computer Center

Dallas headquarters has 32 separate units of electronic equipment costing $2½ million . . . Center will perform a variety of computations at lightning-like speed . . . Among newest and biggest in industry

SEVENTEEN SPECIALISTS trained for two years, a specially designed 4000 sq ft air conditioned room was prepared, and over a month required to install and test equipment . . . were some of the highlights necessary in setting up Mobil Oil Company's giant electronic brain recently in Dallas, Texas. The $2½ million computer, made up of 32 separate but connected units, finally went to work late in September for the first time. Mobil Oil's large computer center is under the direction of L. E. Frensley, comptroller and vice president of the former Magnolia Petroleum Company, which became a part of Mobil on October 1.

The giant computer will process wholesale invoices, figure and print royalty checks, do engineering calculations, prepare reports that are more comprehensive and some that would be too expensive to reproduce without the computer, as well as many other time-consuming computations.

To reach full operation (16 hours a day) of the 705 will require two years. Specific jobs planned for it are these:

1. In wholesale sales of refined products, the 705 will audit sales information, check prices and extensions, and summarize and compare sales information on some 16,000 deliveries a day;

2. It will calculate and price deliveries of crude oil into pipelines, prepare statements on oil leases, and calculate and print 50,000 royalty and working interest checks each month; and

3. In the engineering area, studies will be made of crude oil reserves, exploration methods will be evaluated and correlated, and economic studies will be prepared on proposed gasoline plants and other facilities.

In addition, the 705 is expected to give the company reports that are more comprehensive and some now impractical. Too, the computer should prove beneficial in what's called "management by exception." This involves the flagging of deviations from previously set "norms" in reports on operations. By having the 705 point out these deviations or problems, managers can devote themselves to solving problems rather than to digesting lengthy reports.

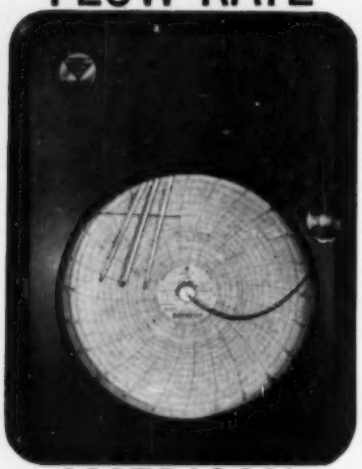
Renting for $43,700 per month, the 32-unit data processing equipment is among the newest and most powerful of its kind in industry today. It's speed is almost unbelievable. For example, it can make 1250 multiplications a second of five-digit numbers. If the contents of the 1037-page novel, "Gone With The Wind" were put on magnetic tape, the computer could read it in just four minutes! It could print the entire contents in just one hour! From the beginning of the planning stages to the completion of a 16-hour daily operation, the time will be equivalent to a man working for 25 years!

All of the interconnected units generate over 300,000 Btu per hour; and with this amount of heat, 90 tons of air conditioning were required for proper operation. Of this 90 tons, 35 tons are on a standby basis. This is enough air conditioning to cool 30 average size homes. The temperature and humidity in the computer room must be closely controlled. A specially raised floor was constructed in order to provide space for the maze of interconnecting cables.

The major task for the giant computer will be to check the price and extension of about 16,000 invoices of deliveries to service stations and other consumers for some 1300 different classes of products. It will also adjust and price 35,000 gage tickets, calculate 50,000 royalty and working interest checks, calculate production and inventory reports, summarize pipeline receipts and deliveries and accounting entries.

This amazing electronic machine cannot do a thing without being told exactly how to do it; and, then all it can do is add, subtract, multiply, divide and compare. The job the machine is to do must first be analyzed in great detail, broken down into a set of step-by-step logical and arithmetic operations, and translated into coded instructions which the machine will then follow. * * *

PRECISION MEASUREMENT AT ANY FLOW RATE



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- Tamper-proof calibration – simple, positive adjustment of float lever arm length.
- Interchangeable ranges – no manifold piping changes.
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- Teflon-packed pulsation dampener externally adjustable under full line pressure.
- Check valves give positive shut-off for over-range protection.

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Laugh with Barney

You can't ever tell how happy a man is by the amount of money he has. A man with ten million dollars may be as happy as one with eleven million.

The Census Bureau reports that for every man who lives to be 85, there are seven women. But by that time it's too late!

A husband is a peculiar creature — he buys his football tickets in June and his wife's Christmas present December 24.

Love is what makes the world go around . . . looking for a psychiatrist.

The difference between "she's good looking" and "she's looking good" is about 20 years and 40 pounds.

The Christmas traffic was heavy. A man and a woman driver collided at a busy intersection. A nearby policeman walked over, listened to the dispute, and offered this advice to the man:

"I'd settle if I were you, sir. After all, it's your word against literally thousands of hers."

The office drinking fountain . . . "Old Faceful."

If your wife doesn't treat you as she should . . . Be Thankful!

Oilman's wife at Christmas party: "Where is that cute blonde who was serving cocktails a while ago?"

Hostess: "Oh, are you looking for a drink?"

Oilman's wife: "No, I'm looking for my husband!"

It was New Year's Eve. A Salvation Army lassie was standing on the corner testifying, "I was a sinner," said she, "who flitted from dance hall to dance hall. I drank liquor every night. I smoked constantly. I did everything bad. But I was saved, and now I don't dance, I don't drink, I don't smoke, I don't sin any more at all. In fact, I don't do a darn thing but hang around here and beat this lousy drum."

After the ceremonies were over celebrating the unveiling of a bust of an old college professor, a pretty young lady walked up to him and said:

"I hope you appreciate me," she cooed, "I came 50 miles to see your bust unveiled."

"My dear young lady," replied the gallant professor, "I would travel a thousand miles to see yours."

Then we heard one about the guy who could always find the liquor, no matter where his wife hid it. He had a fifth sense.

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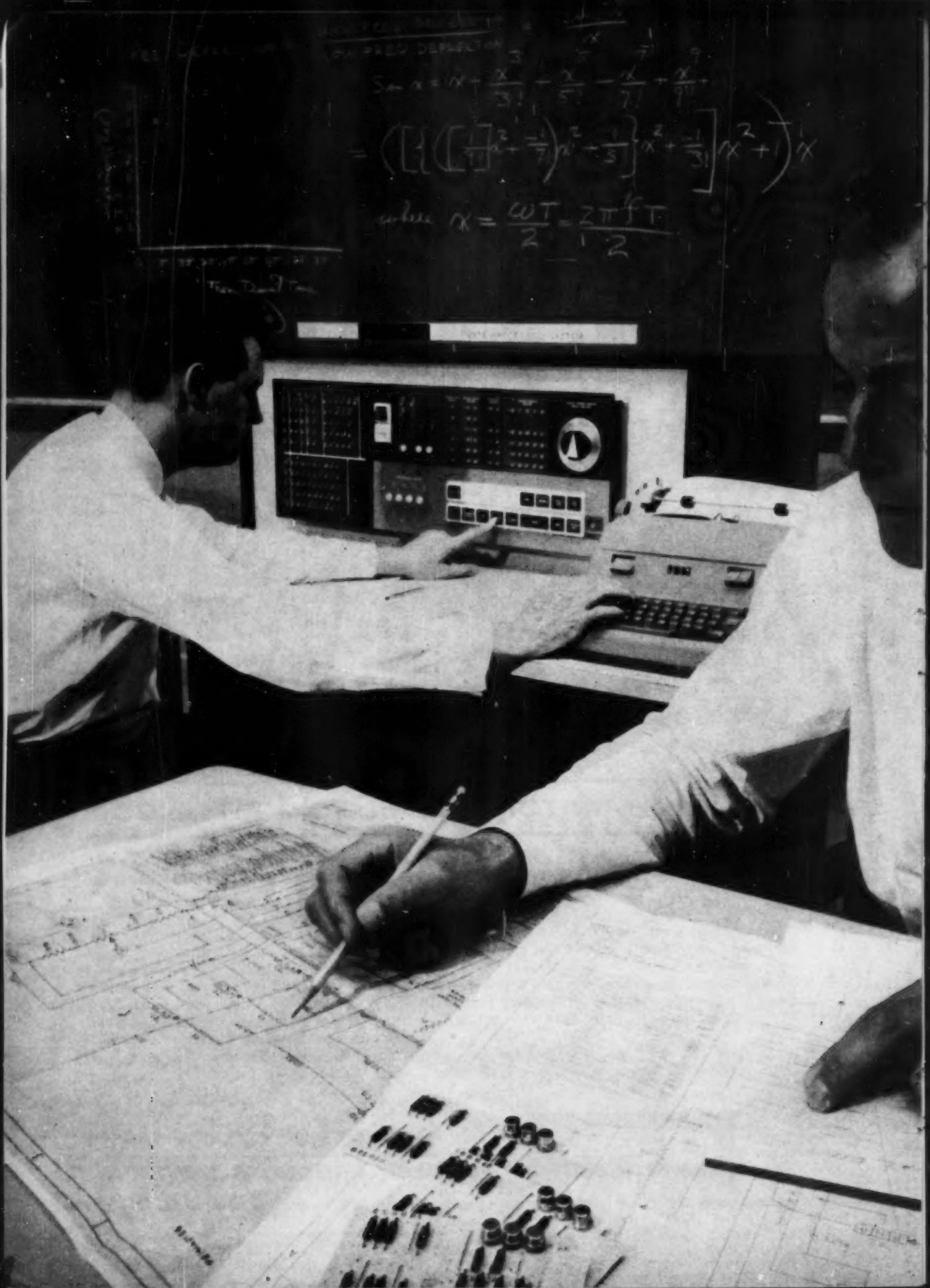

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Programming is simplified through the use of IBM Fortran—a mathematical programming system which compiles machine instructions from algebraic and English language notation. A library of programs for standard engineering computations will also be part of the 1620 package.

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Management Personals

David F. Edwards, manager of Esso Standard's Bayonne (New Jersey) refinery, has joined the new Delaware corporation, Humble Oil & Refining Company, where he becomes employee relations manager. **Lester R. Moore,** presently secretary and treasurer of Esso Standard, will become treasurer of the new Humble Oil. Others

D. F. Edwards

L. R. Moore

invited to join the new company are **G. B. Edwards,** presently controller of the Carter Oil Company, Tulsa, Oklahoma, as head of the tax department and **L. J. Weigle,** manager of the Southern division of Carter, secretary.

Richard J. Gonzalez, presently a director and treasurer of Humble Oil & Refining Company, Texas, will be coordinator of finance and economics of the new company; **Nelson Jones,** presently general counsel of Humble, will be general counsel, and **Oral L. Luper,** presently controller of Humble, will be controller.

Robert O. Goodykoontz, J. Prince Warner and **Frederick P. Hagaman** were elected to the Esso Standard Oil Company's board of directors. Goodykoontz, general manager of marketing, and Warner, general manager of manufacturing, were elected vice presidents of Esso Standard in August. Hagaman has served as controller since 1948.

A. C. (Bill) Rose Jr., who has served as associate director of the Louisiana Petroleum Council for the past year, has resigned to accept the position of executive vice president with the Colorado Petroleum Committee in Denver.

William H. Price was elected a vice president of Cities Service Petroleum, Inc. Formerly a staff executive in the manufacturing department, Price in his new capacity will serve as executive assistant to **A. P. Frame,** senior vice president of the parent Cities Service Company, in charge of manufacturing, research and petrochemicals.

Robert D. Weppler was appointed manager of the advertising and sales promotion department of Cities Service Oil Company (Pa.) Weppler has been with Cities Service since 1952 and served in various capacities, his latest being merchandising supervisor of the company. He succeeds **Raymond C. Keck,** who has become advertising manager of Cities Service Petroleum.

Four high-level appointments in Mobil Oil Company have been announced jointly in New York by **R. D. Hanley** and **Henry L. Waszkowski Jr.,** divisional vice presidents for exploration and producing in Midland and Houston respectively. **Wade G. Moriarty,** formerly assistant general superintendent in the producing department in Dallas, as manager of producing for the Midland division. **Owen H. Blexrud,** formerly area geologist in the Dallas exploration department, becomes manager of exploration for the Midland division. **E. L. Downing,** formerly general superintendent of the producing department in Dallas, as manager of producing for the Houston division. **Paul E. Nash,** formerly chief geophysicist in Dallas, becomes manager of exploration for the Houston division.

D. W. Devaney, Houston, Texas, was promoted to manager of industrial relations for Continental Oil Company's southwestern region, with headquarters in Fort Worth, Texas. He formerly was director of training for Conoco's manufacturing department, with headquarters at Houston.

M. E. Elliott, Ponca City, Oklahoma, was promoted to general auditor. Formerly assistant general auditor, he will continue to make his headquarters at Ponca City and succeeds **L. E. Teverbaugh,** who retired.

J. A. Rogers, former chief geologist of the domestic producing department of Texaco Inc., has been appointed assistant division manager of New Orleans division. Rogers succeeds **L. W. Calahan,** now division manager of Dallas division.

Also in that department, **W. W. Moore,** division geologist of the New Orleans division, was advanced to assistant division manager, Houston division. **R. B. Palmer,** assistant division geologist of Midland division, was promoted to succeed Moore. **Kenneth E. Myron,** geologist on the general manager's staff, has been promoted to staff geologist of the vice president's office, New York. **R. E. Hunt,** geologist on the general manager's staff, appointed assistant division geologist of Midland division, and **Homer O. Woodruff** is appointed assistant to the vice president, with headquarters in New York. He was division manager in Tulsa.

Assistant Secretary of the Interior **Royce A. Hardy** announced the appointment of **Lawrence J. O'Connor Jr.,** as assistant director in the Department's Office of Oil and Gas. O'Connor, who replaces **Ralph S. Fowler,** in 1945 joined the Goldston Oil Corporation, Houston, Texas, where he advanced to the position of vice president and treasurer. The corporation engaged in oil exploration and production activities and developed oil and gas production in ten States and Canada. Since October 1958, he has been a consultant engaged in special studies and programs for future oil and gas exploration activities. He also was a member of a planning and coordinating group managing offshore drilling operations in the Gulf of Mexico.

M. Darwin Kirk and **Stanley B. Breitweiser** were elected directors of Sunray Mid-Continent Oil Company. They succeed **Edward Howell,** Oklahoma City, and **E. M. Rouzer,** Baltimore, Md., both of whom have retired. Kirk was vice president and general counsel. Breitweiser is executive vice president for DX Sunray Oil Company, the refining and marketing subsidiary.

Bruce E. Thauburn was employed as staff assistant to **Denver R. Williams,** manager of the Ohio Oil Company's crude oil purchase and sales department, and will headquarter in the company's general offices, Findlay, Ohio. He comes to Ohio Oil from the economics department of Arabian-American Oil Company's New York City office.

W. R. Cooper, the Arabian American Oil Company's general manager for engineering and construction, was elected a vice president of Aramco, assuming responsibility for all engineering and construction activities of the company. **L. M. Snyder,** who had been vice president in charge of engineering, construction and local sales, was named vice president in charge of relations, succeeding **R. A. Eeds,** who has resigned to become president of Esso Standard (Libya) Inc., a subsidiary of Standard Oil Company (New Jersey). Snyder remains responsible for local sales. Cooper and Snyder will continue to make their headquarters in Dhahran, Saudi Arabia.

W. R. Cooper

Marshall McDonald

Marshall McDonald, president of an investment company and an insurance company in Houston, Texas, was named vice president and financial coordinator for Sinclair Oil & Gas Company in Tulsa. He will be coordinator for the accounting, treasury, economics, insurance and data processing departments.

Raymond A. Semrad was named department manager of the new data processing department of Sinclair O & G. The department previously was a section of the accounting department.

Paul Wollstadt, assistant to the chairman of the board, was named to the newly created position of vice president-employee and public relations of Socony Mobil Oil Company, Inc. **Don Sweeney,** who was manager of the Mobil International section of the Socony Mobil public relations department, was appointed manager, succeeding Wollstadt.

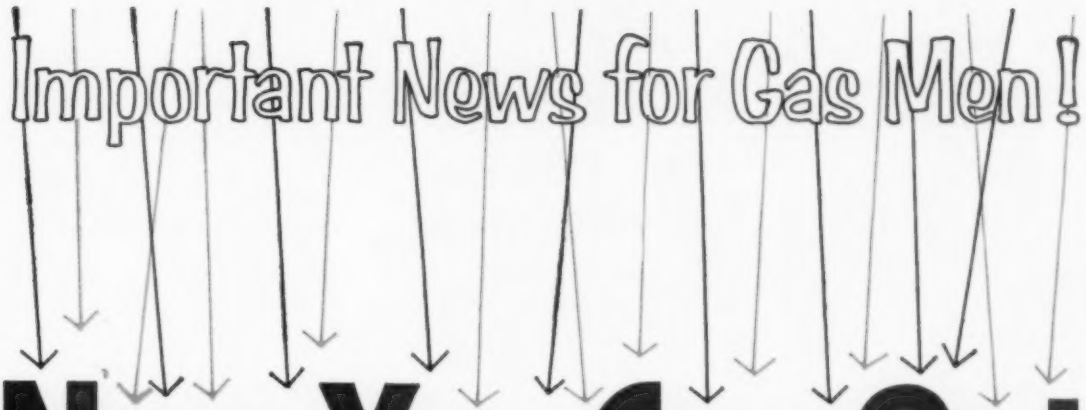
Forrest N. Shumway was named secretary of Signal Oil and Gas Company. A member of Signal's legal staff since 1957, Shumway became assistant secretary in that year and was named a director of the company in January 1959. In his new capacity Shumway succeeds **A. E. Stebbings,** director, whose increasing duties as general manager of Signal's marketing department necessitated the change.

Henry A. Witcher has been promoted to superintendent of operations in the general offices of the gas and gas products department, Tulsa, Sinclair Oil & Gas Company. He was formerly serving as Houston division superintendent of the department.

William C. Hildebrand was named vice president of the Bay Petroleum Company, a division of the Tennessee Gas Transmission Company.

William W. Wicks has joined the public relations department of Standard Oil Company (Indiana) as supervisor of field services. He was manager of public relations for a division of Diamond National Corporation.

Merwin Bristol was elected a director and general counsel of Standard (Indiana). He was formerly associate general counsel. **Richard J. Farrell,** assistant general counsel, was named to succeed Bristol.



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WEST COAST FACTORY: WOODLAKE, CALIFORNIA

Personals

Howard C. Sheperd, chairman of the board of the First National City Bank of New York, was elected a member of the board of directors of Sinclair Oil Corporation. He succeeds **Wm. Gage Brady Jr.,** who has served on the Sinclair board since 1954.

Lee M. Fuller, since 1951 an assistant treasurer of Sinclair Oil, was elected a vice president. He succeeds **Iver J. Bergholt** who recently was elevated to vice president and treasurer. **J. P. Downer** was named an assistant treasurer.

H. F. Tomfohrde was appointed transportation manager, home office, of Tidewater Oil Company. Tomfohrde, formerly manager of Tidewater's eastern division transportation and supply department, makes his headquarters in Los Angeles.

Eugene Hosford, operations coordinator of the domestic production department of the Gulf Oil Corporation, is the new executive vice chairman of the Texas Oil Information Committee. **Cecil Colville,** administrative assistant to the management of Sun Oil Company's Southwest production division, was appointed community programs vice chairman.

John S. Freeman has resigned as president and director of Skelly Oil Company. **Don H. Miller,** marketing division general manager at Kansas City, was named to succeed Freeman. **Harold C. Stuart,** Tulsa lawyer and television-radio executive, was elected to fill Freeman's place as a director.

DEATHS

James A. Cashen Jr., 61, retired manager of wholesale sales for American Oil Company, died in Hudson, New York on October 20.

Volney B. Fowler, 62, director of public relations for Electro-Motive Division of General Motors and former managing editor of the *Indianapolis, Indiana, Times,* died October 6.

Frank J. Trelease, 72, pioneer builder of natural gas pipelines whose career as a civil engineer spanned half a century, died October 2 in Oxford, Maryland. He retired in 1947 as a senior consulting engineer with Ford, Bacon & Davis, Inc., after 33 years with the firm.

J. Patrick D'Artois, 51, resident manager of The Ohio Oil Company of Guatemala, died October 23 in Guatemala City, Guatemala, of complications following a heart attack.

J. O'C. (Jim) Brown, 62, vice president of Petro-Tex Chemical Corporation, and over 43 years in the petroleum and rubber industries, died in Houston, Texas, October 2 after a prolonged illness.

Sumner B. Sargent, 58, president of Sargent Engineering Corporation, of Huntington Park, California died October 18 of a heart attack while hunting with friends near Big Piney, Wyoming.

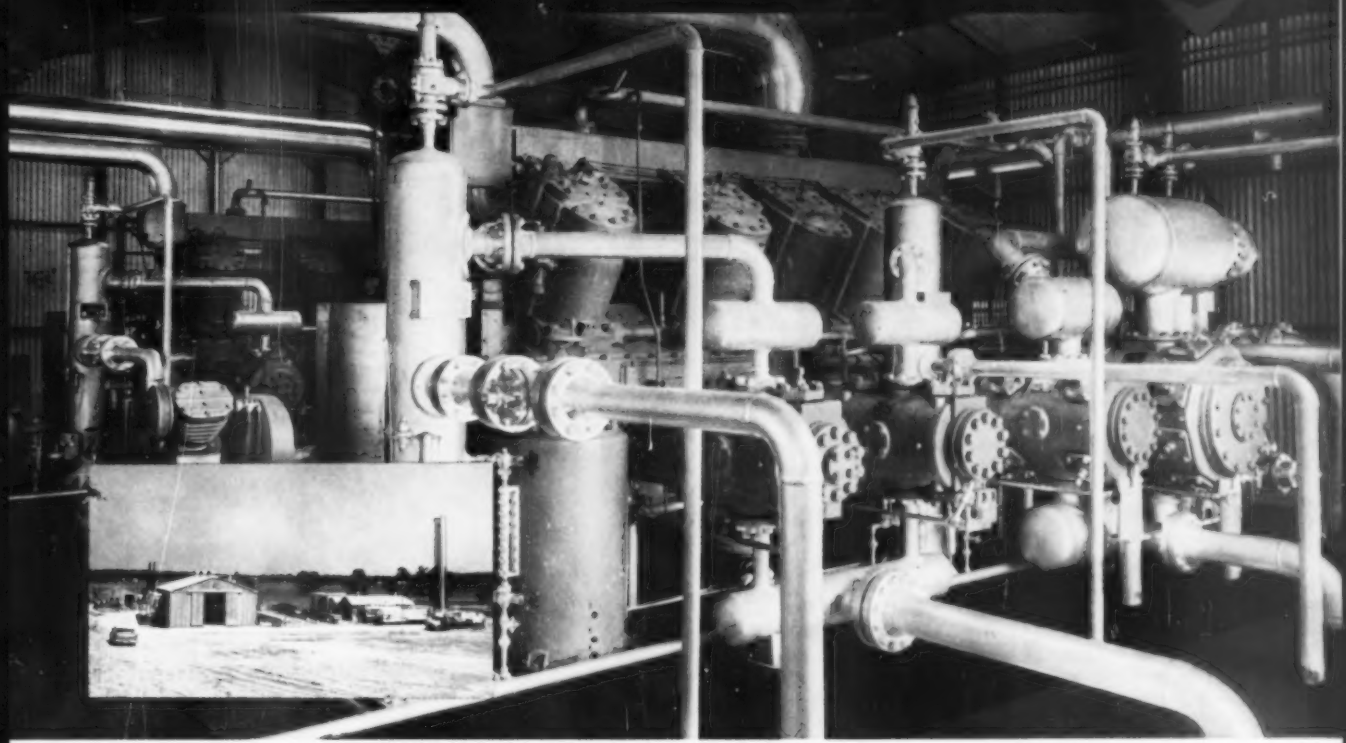
Harry R. Miller, labor relations manager for Standard Oil Company of California, died of a heart attack while on a business trip to Perth Amboy, New Jersey. He was 53.

Rolland W. Phillips, 55, assistant general manager of the Texas Pipe Line Company, a subsidiary of Texaco Inc., died of a heart attack October 13 in his home in White Plains, New York.

H. D. Zerfass, vice president of Latex Construction Company of Georgia, died October 22.

Robert L. Rowland, 76, retired Service Pipe Line Co. employee, died at his home in Columbia, Missouri, October 28.

BEAIRD-INGERSOLL-RAND Packaged Compressor Plant



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Packaged Compressor Equipped . . .

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Robert Cargill, operates this gas processing plant in the Tatum-Petit Field. Located just outside the city limits of Tatum, Texas, the field has grown from a single wildcat to 75 producing wells in less than three years. During this swift expansion it became evident that the increasing number of high gas-oil ratio wells would curtail oil production unless a means was provided to conserve the excess gas. An additional problem was created by the wide variation of wellhead pressures which ranged from 25 psig. to 650 psig.

Engineers called in by Robert Cargill solved the production problem by designing a gas processing plant to remove heavy elements as marketable by-products and to boost the dry gas to a nearby sales line. Two Beaird-Ingersoll-Rand 10SVG 550 horsepower packaged compressors were selected for the main station. Each compressor has been engineered to handle both low and high pressure streams. Low pressure gas is boosted through three compression stages then tied into the discharge of the fourth cylinder which boosts the high pressure stream. The plant can process 20 mmcfd. at 850 to 1,000 psig. discharge with its present arrangement.

As future requirements demand, additional packaged units may be economically installed to handle the increased load. When the field is depleted the compressors may be moved to other service with little or no change in piping or manifolding.

Let us assist you in planning an economical solution to your production problem. Call or write . . .

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Shreveport, Louisiana
A Subsidiary of American Machine & Foundry Company

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another AMF product
PACKAGED COMPRESSOR PLANTS

LOWEST COST PER HORSEPOWER INSTALLED

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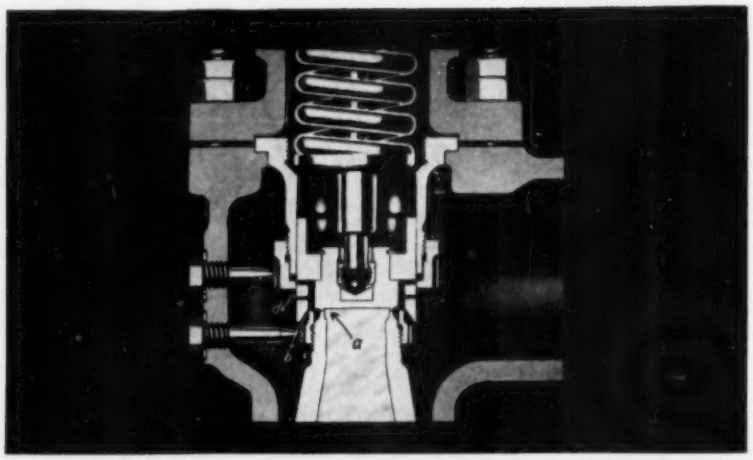

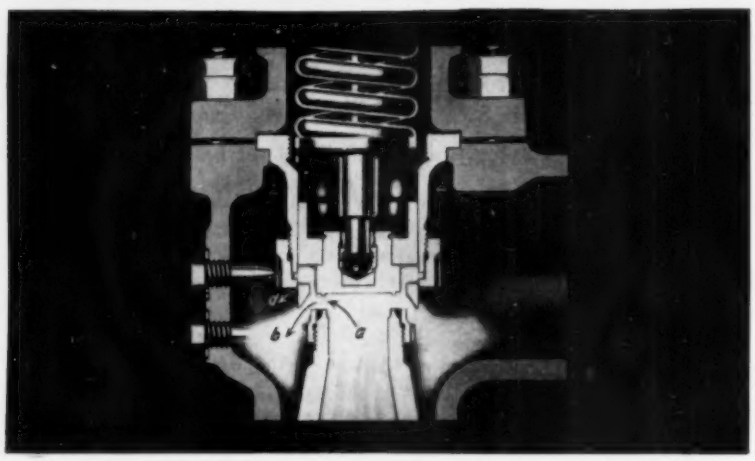

Top: Valve closed, ready to pop. Pressure confined within throat chamber. Bottom: Open. Full (D/4) lift obtained at standard over-pressure. Orifices (a) and (b) full open, port (d) sealed off. Full pressure on baffle area.

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Lonergan V and W series valves are designed to provide full power at the *end of lift* when opening. This means full lift, thus maximum capacity flow at a low accumulation.

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Meetings

1960

Jan. 22 — Natural Gasoline Assn. of America, Gulf Coast regional meeting, Robert Driscoll Hotel, Corpus Christi, Texas.

Jan. 31-Feb. 5 — American Society of Testing Materials, a committee D-2 meeting, Statler Hotel, Detroit, Mich.

Feb. 14-18 — AIME, annual meeting, Statler Hilton and McAlpin hotels, New York, N. Y.

Feb. 18-20 — The National Society of Professional Engineers, winter meeting, Broadview Hotel, Wichita, Kans.

Feb. 26 — Natural Gasoline Assn. of America, Permian Basin regional meeting, Lincoln Hotel, Odessa, Texas.

Mar. 2-4 — API Division of Production, southwestern district meeting, Statler-Hilton Hotel, Dallas, Tex.

Mar. 6-9 — American Society of Mechanical Engineers, Gas Turbine Conference and Exposition, Rice Hotel, Houston, Tex.

Mar. 14-18 — National Assn. of Corrosion Engineers, annual meeting, Memorial Auditorium, Dallas, Tex.

Mar. 16-18 — API Division of Production, southern district meeting, Hilton Hotel, San Antonio, Tex.

Mar. 18 — Natural Gasoline Assn. of America, Oklahoma regional meeting, Biltmore Hotel Oklahoma City, Okla.

Mar. 21-23 — Midwest Gas Assn., annual meeting, Hotel St. Paul, St. Paul, Minn.

Mar. 29-31 — Illinois Institute of Technology, annual American Power Conference, Hotel Sherman, Chicago, Ill.

Mar. 30-Apr. 1 — API Division of Production, Mid-Continent district meeting, Broadview Hotel, Wichita, Kans.

Apr. 4-6 — API Division of Transportation, highway conference, Shamrock-Hilton Hotel, Houston, Tex.

Apr. 12-14 — Petroleum Industry Electrical Assn. and Petroleum Electric Supply Assn., annual conference and exhibition, Municipal Auditorium, Kansas City, Mo.

Apr. 18-19 — Conference on Automatic Techniques, annual meeting sponsored by National Conference Committee (ASME, IRE, AIEE), Cleveland Sheraton Hotel, Cleveland, O.

Apr. 19-21 — Southwestern Gas Measurement Short Course, North Campus, University of Oklahoma, Norman, Okla.

Apr. 20-22 — API Division of Production, Rocky Mountain district meeting, Gladstone, Henning, and Townsend hotels, Casper, Wyo.

Apr. 20-22 — National Petroleum Assn., semiannual meeting, Hotel Cleveland, Cleveland, O.

Apr. 24-26 — Independent Petroleum Assn. of America, midyear meeting, Denver Hilton Hotel, Denver, Colo.

Apr. 25-27 — Southern Gas Assn., convention, Buccaneer and Galvez hotels, Galveston, Tex.

Apr. 25-28 — American Assn. of Petroleum Geologists-Society of Economic Paleontologists and Mineralogists, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

Apr. 25-29 — American Welding Society, annual meeting and welding exposition, Los Angeles, Calif.

Apr. 27-29 — Natural Gasoline Assn. of America, annual convention, Rice Hotel, Houston, Tex.

Apr. 28-29 — API Division of Transportation, pipeline conference, Mayo Hotel, Tulsa, Okla.

May 9-12 — API Division of Refining, midyear meeting, Statler and Sheraton-Cadillac hotels, Detroit, Mich.

May 12-13 — API Division of Production, Pacific Coast district meeting, Biltmore Hotel, Los Angeles, Calif.

May 26-27 — Society of Petroleum Engineers of AIME, annual joint meeting of Rocky Mountain petroleum sections, Calgary, Alberta, Can.

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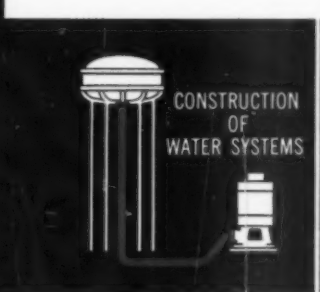

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• News • People The Trade PARADE

▸ **National Tank Company.** L. S. "Spider" Allen, for the past 20 years head of the Armco Surface Casing Division, retired. John H. Shelton, manager of National's West Texas Division in Midland, Texas, for the last 11 years, replaces Allen. Assisting Shelton will be Dale Williams, with the Tulsa office since 1953. He will be Tulsa city salesman. Jack Williams, engineer and branch manager of the Odessa branch since 1950, replaces Shelton. Harold Jones, currently branch manager at Farmington, New Mexico, will take over the Odessa branch and J. D. Fowler, sales and service engineer in the New Mexico branch, replaces Jones.

▸ **Empire Geophysical, Inc.** Robert G. McCuistion, seismic party chief, was promoted to supervisor. He will work out of Empire's Midland regional offices.

▸ **Bethlehem Steel Company.** A. T. Hunt is appointed chief engineer succeeding H. E. Davidson, deceased. P. H. Jezzard is appointed machinery application engineer and R. J. Oliphant is appointed supervisor of the production controls department.

A. T. Hunt has been affiliated with Bethlehem's Supply Division since 1945 and has been assistant chief engineer since 1947. P. H. Jezzard joined Bethlehem in 1946 and served as machinery service engineer in charge of the service department since 1955. R. J. Oliphant was employed in 1936 as chief clerk in the accounting department, most recently being works accountant.

▸ **The Warner Lewis Company, Division of FRAM Corporation.** Virgil C. Gallman has joined the sales department. He will handle sales and service in Oklahoma and southern Kansas.

▸ **United States Steel Corporation.** John Pugsley has been elected executive vice president-accounting, with headquarters in Pittsburgh. Wilbert A. Walker is administrative vice president and comptroller. Marcus M. Fisher and C. Burton Vernooy are administrative vice presidents-accounting. George W. Rooney, executive vice president-accounting has retired after 33 years of service with the corporation and its divisions.

▸ **E. I. du Pont de Nemours & Company.** Joseph G. Evans and James G. McIlhiney have been named managers of the Cleveland and San Francisco district offices, respectively, of Du Pont's Petroleum Chemicals Division.

▸ **Dow Chemical Company.** Fred K. Quigley, Jr., was promoted to staff manager of coating materials plastics department. He succeeds E. K. Stilbert, recently named a product group vice president of Dow Chemical International Limited S. A.

▸ **Jones & Laughlin Supply Division.** B. H. Milner was appointed store manager at Alice, Texas. He had been storeman at the Luling, Texas store.

H. C. King was assigned as regional salesman, production machinery at Pampa, Texas. He was formerly district sales manager at Regina, Saskatchewan, Canada. King will report to F. L. McFarland, regional manager at Midland, Texas.

Two J & L salesmen who received new assignments are B. G. O'Brien, salesman at Salem, Illinois to Greensburg, Kentucky, and J. H. Rankin, salesman at Kermit, Texas, to Hobbs, New Mexico.

▸ **Jefferson Chemical Company, Inc.** Douglas M. Stuart was appointed to the sales staff. He is assigned to the Cleveland, Ohio, regional sales office.

Peter S. Vail is also named to the sales staff but will be assigned to the regional sales office in Chicago.

▸ **Kellogg Switchboard and Supply Co.** Hugh J. Tremblay was appointed manager of military systems sales. He will be responsible for sales of military communications systems, and previously served as coordinator of government relations.

Worth Probst was named comptroller and treasurer. He was comptroller of Carrier Corporation.

▸ **Rockwell Manufacturing Company.** Brigadier General Joseph M. Colby, Deputy Commanding General, U. S. Army Ordnance Missile Command at Redstone Arsenal, Alabama, was named vice president of engineering. C. A. Wiken, vice president of research and engineering, becomes vice president of research and development.

Bobby G. Stoops, assistant chief engineer at the instrument division in Tulsa, has been promoted to chief products engineer. Nelson E. Davenport, export sales manager — meter and valve products, is named assistant to the vice president of the petroleum and industrial meter division. Walter G. George, export sales manager — power tools and municipal products, is appointed manager of the export department.

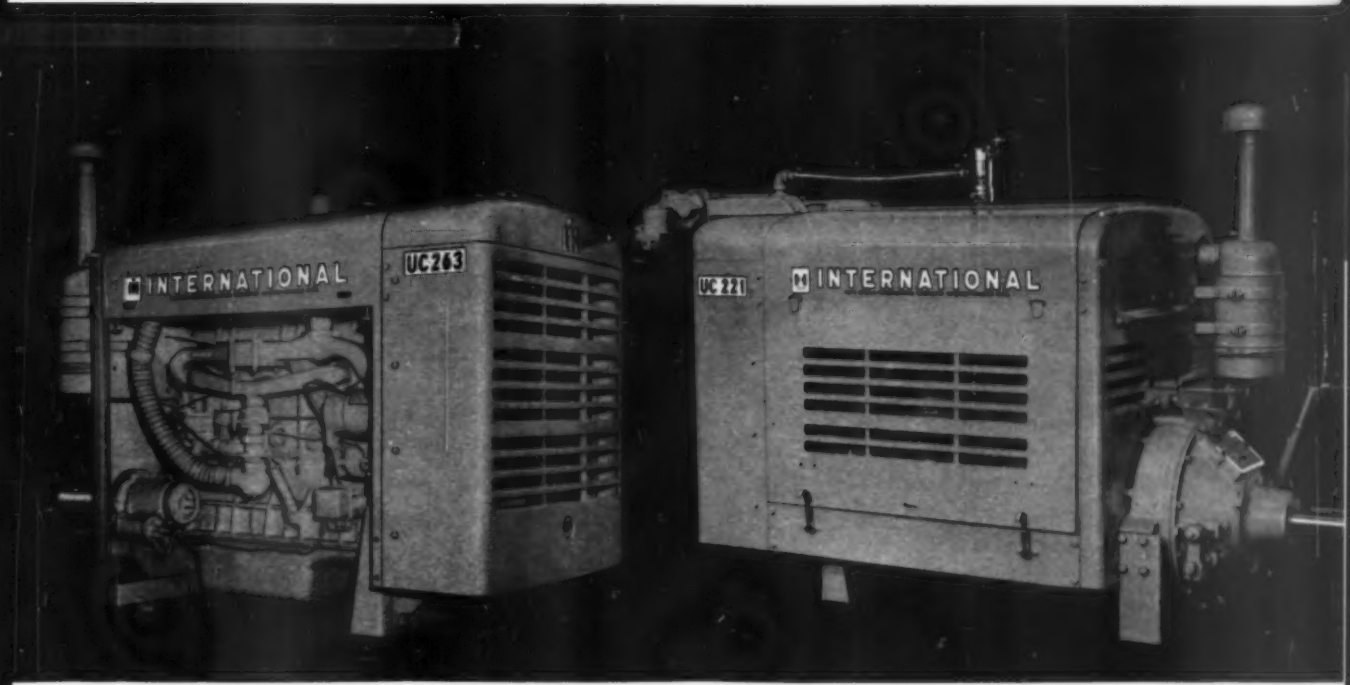
▸ **KLM Royal Dutch Airlines.** Wayne Tilton has joined KLM as a transportation consultant to the petroleum industry. He was with the Robert H. Ray Company, Houston, Texas, since 1952 stationed in Saudi Arabia, Tripoli, and Libya.

▸ **The Larkin Packer Company.** Wally Holmberg was appointed to the newly created position of controller with headquarters in Waxahachie, Texas. He was public relations supervisor. E. L. Meredith was named the new warehouse manager in Tulsa, Okla., vacated by Leo Cragg, retired.

▸ **Loffland Brothers Company.** Ken Davis Jr., president of Kendavis Industries, Inc., International, has announced that he will assume the duties as president of Loffland Brothers domestic companies with headquarters in Tulsa, Oklahoma. Prior to joining Loffland Brothers several years ago, Davis was president of Unit Rig & Equipment Co., Tulsa, Oklahoma. Presently he is chairman of the board of Unit Rig. J. O. Rundle was named president of all Loffland Brothers foreign companies, and T. W. Wheeler is executive vice president of Loffland Brothers domestic companies.

▸ **Link-Belt Company.** Charles W. Beauchamp was appointed marketing manager and will head up all sales activities of Ewart plant in Indianapolis. Kendrick M. Hickman is sales manager. The appointments follow the retirement of Forest H. Spencer after 40 years of service.

▸ **Cameron Iron Works, Inc.** J. F. Allen was promoted to manager of manufacturing of the pressure control equipment division. He was manager of Cameron's guided missile plant. Harry H. Walsh, formerly manufacturing engineer for the missile activity, succeeds Allen as missile plant manager.



New UC-263 with 82 max. hp. rating @ 2400 on LPG.

New UC-221 enclosed power unit develops 60 max. hp. @ 2400 rpm. on natural gas.

Two NEW heavy-duty International 6-cyl. engines cut pumping costs

Two new 6-cylinder heavy-duty engines in the 75-95 max. hp. class, the UC-221 and UC-263, have been added to the line of International oil field engines that protect production and cut pumping costs.

Both the UC-221 and UC-263 carbureted engines have inherent diesel ruggedness. This is because each differs from an interchangeable diesel engine in the International line principally in cylinder head and piston sections. Features contributing to smooth, efficient, economical power include: valve-in-head design; best compression ratio for selected fuel; low-friction stepped-dome pistons; replaceable cylinder sleeves; fully machined combustion chambers for uniform power from each cylinder; and 12-volt electrical system.

Attachments that adapt either engine to your oil field needs include; fuel attachments for natural gas, combination natural gas and gasoline, and LPG; exhaust condensor, top cylinder oiler, automatic safety shut-off; automatic radiator shutter, horizontal high tension magneto and gear-driven mechanical governor.

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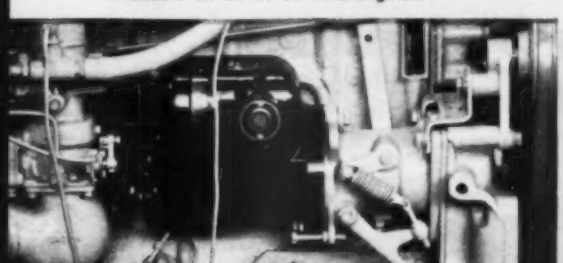
Mechanical governor and horizontal magnetos are available on all IH oil field engines.



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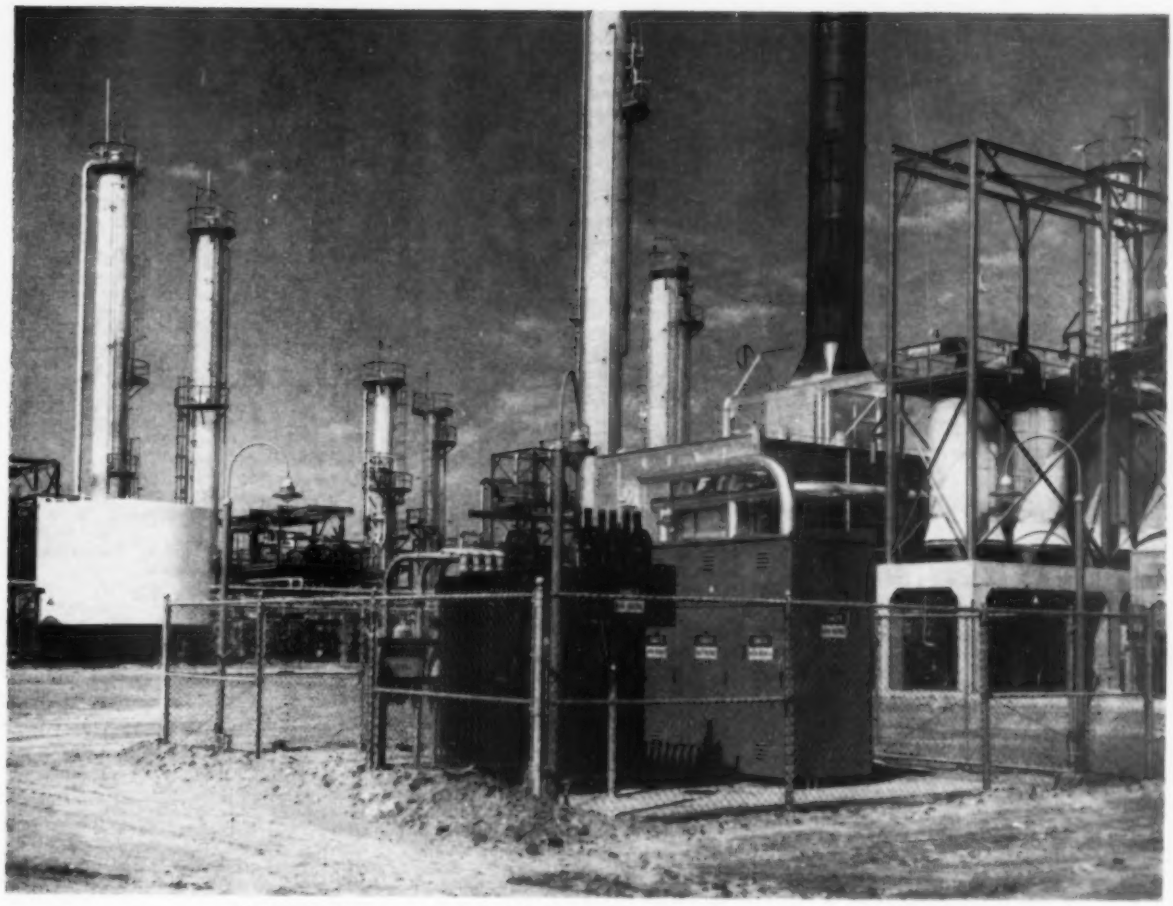

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Trade Parade

▸ **Lone Star Steel Company.** Marino R. Anderson was named export sales representative.

▸ **J. I. Case Company.** Donald H. Mitchell has joined the company as manager of the newly-formed industrial products division. S. W. Brock, formerly sales representative of the Case Clausen Works in Racine, is assistant manager of the new division. G. W. Watts is in charge of technical information.

Conrad L. Daniels is named works manager of the Rockford, Illinois, plant. Lawrence H. Hodges, former works manager, was promoted to a top position in central engineering at the headquarters in Racine.

Dr. I. Richard Gregor has been appointed director of manufacturing for foreign operations. Prior to joining Case he was associated with the Kearney and Trecker Mfg. Corp. of Milwaukee.

▸ **Caterpillar Tractor Company.** Dale W. Turnbull, district representative in Oklahoma and Kansas, was promoted supervisor of wheel tractors and motor graders, product section of product division.

▸ **Collins Radio Company.** Two microwave sales representatives are Donald F. Snyder, serving the Rocky Mountain states with offices in Denver and Robert M. Millner, the North Central states, headquartering in Minneapolis.

▸ **American Cyanamid Company.** James Boyd Smith was appointed manager of sales development for refinery chemicals by the industrial chemicals division. He has served as a sales representative in the refinery chemicals department's Houston office.

▸ **Cooper-Bessemer Corporation.** Tom M. Lamberth Jr., was promoted assistant to southwest district manager. Clifton W. Woltz was appointed branch manager of the Shreveport office replacing Lamberth. Lamberth will work under the direction of C. Horace Sanders, Southwest district manager, at the offices in Dallas, Texas.

Laurence B. Hume was named assistant manager power engine sales. He will work directly under R. Spetka, manager.

▸ **Dowell Division,** The Dow Chemical Company. Ray S. Ousterhout, assistant general sales manager, has moved from Tulsa to the Dallas offices, 300 Vaughn Building. He will be in charge of Dallas and Ft. Worth operations.

▸ **The Frank G. Hough Co.** David D. Hunsaker was named manager, sales development, "Payloader" section. He was formerly a district manager.

▸ **Hughes Tool Company.** Calvin D. Sholtess was named division sales manager with headquarters in Bakersfield, California. Other personnel changes included the promotion of Thomas E. Dobbins to regional sales coordinator at Denver, Colorado; Leonard G. Parrott to regional sales coordinator at Dallas; M. Gordon Clarke to regional special sales representative at Dallas; and Dean L. Leyerly and Floyd E. Van Hook, division special representatives at Farmington, New Mexico, and Oklahoma City, respectively. Julien Muller is now regional special sales representative in Houston and H. T. Oliphant is regional special sales representative with headquarters in Los Angeles.

▸ **E. I. du Pont de Nemours & Co.,** Petroleum Chemicals Division. J. Morgan Ogilvie, sales service representative in the Chicago district, became sales promotion coordinator in the division's Eastern Region, replacing Robert A. Paulsen who moved to the Gulf Coast regional office at Houston, as account manager and sales promotion coordinator. Charles S. Russ moves from the Gulf Coast Region, where he has been account manager and sales promotion coordinator, to the division's headquarters in Wilmington, Del., as techcal assistant in the sales promotion section. James M. Poole transferred from the latter section to the division's Eastern region as an account manager. Raymond A. Blank moves to the Mid-Continent region in Tulsa, Okla., as an account manager.

▸ **The Enjay Company, Inc.** J. P. Haworth, H. C. Evans and G. H. Lowden were appointed assistant sales manager, Eastern division manager and Akron district manager, respectively. Haworth was former Eastern division manager, Evans former Akron district manager, and Lowden, representative in charge of the company's Detroit office.

▸ **Engineered Oil Tools, Inc.** Bob L. Smiley was appointed sales engineer for the Northern division. He represents the line of Johnston hydraulic pumping units and related engineered production equipment items in North Texas, the Panhandle, Oklahoma, Kansas and Canada for Engineered Oil Tools.

▸ **Gulf Coast Machine & Supply Company.** Jerry Forcher has transferred from the Corpus Christi district to Wichita Falls. He will represent Gulfco in the north central Texas district with division headquarters in Dallas.

▸ **Motorola Communications & Electronics, Inc.** Willis Ditmanson was named national parts and service manager. He will coordinate the service organization which provides contract maintenance and other service aids to industrial, public safety, transportation, and commercial users of mobile radio and other communication networks.

Charles Herrin was named sales manager, two-way radio products, for the 10 state Western area consisting of Washington, Oregon, California, Idaho, Nevada, Wyoming, Montana, Colorado, Utah and Arizona.

▸ **Mission Manufacturing Company.** Charles A. Vogel was appointed sales representative for the Northeast district with headquarters in Philadelphia. Vogel primarily will be responsible for sales of the Hammerdril, Mission pneumatic tool for quarry and mining operations.

▸ **Schlumberger Well Surveying Corporation.** E. C. Bevins was promoted location manager at Fairmont, West Virginia. In the Pacific division headquartered at Los Angeles, H. C. Wiese was named sales engineer; J. H. Gallois moves to the Pacific division to assume the duties of senior sales engineer. Former field engineer at Midland, Texas, W. R. Lewis, is named sales engineer for that location.

▸ **Security Engineering Division,** one of the Dresser Industries. Joe McGraw, Jr. was appointed division manager for the Rocky Mountain area. Formerly was a regional sales representative, out of Tulsa.

—CLASSIFIED—

COLLECTOR'S ITEM

November, 1939, through October, 1959, issues of The Petroleum Engineer for sale. Reasonably priced. George B. Shelton, U. S. Department of the Interior, P. O. Box 911, Amarillo, Texas.

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You can exchange with confidence. When you purchase a Caterpillar Exchange Assembly, you can be sure it's been reconditioned by trained experts using authorized techniques, and only *genuine* Caterpillar parts are used. Every assembly exchange item is backed 100% to be in first-class condition.

Any way you look at it, Cat Parts Assembly Exchange is a good deal. You get a dependable, guaranteed exchange unit at approximately the same cost had you done the job yourself—and the time saved can be converted into cash by having your machine working and earning. Contact your dealer today for his list of Parts Assembly Exchange Units and prices.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

EQUIPMENT RENTAL AVERAGES DURING 1958*
as compiled by Associated Equipment Distributors

CRAWLERS	PER DAY DIRECT DRIVE	PER DAY TORQUE CONVERTER
D9	$296.00	$386.00
D9 w/No. 9A Dozer	367.00	457.00
D9 w/No. 491 Scraper	497.00	507.00
D8	211.00	330.00
D8 w/No. 8A Dozer	270.75	398.25
D8 w/No. 463 Scraper	366.00	485.00
D7	142.00	
D7 w/No. 7A Dozer	188.25	
D7 w/No. 435 Scraper	265.00	
D6	107.00	
D6 w/No. 6A Dozer	148.50	
D6 w/No. 60 Scraper	179.75	
D4	74.75	
D4 w/No. 4A Dozer	109.50	
D4 w/No. 40 Scraper	113.40	

MOTOR GRADERS	PER DAY
No. 14	$138.00
No. 14 w/Scarifier Attach.	149.00
No. 12	117.00
No. 12 w/Scarifier Attach.	125.75
No. 112	93.00
No. 112 w/Scarifier Attach.	110.85
WHEEL TRACTORS w/2-WHEEL SCRAPER	
DW21-No. 470	$382.00
DW20-No. 456	482.00
DW15-No. 428	205.00
TRACTOR LOADERS, FRONT END LOAD and DUMP	
No. 977	$199.00
No. 955	108.00
No. 933	85.75

*Figures are national average rates and in no way reflect the going rate in any area, and cannot be so used. Actual rental costs vary depending on local practices and conditions.

SERVICE TIP

BEFORE you begin to tear down your equipment to remove a parts assembly, check with your Caterpillar Dealer on availability and delivery. The big advantage of Parts Assembly Exchange is in having the reconditioned unit ready to go on as soon as the worn one is off.

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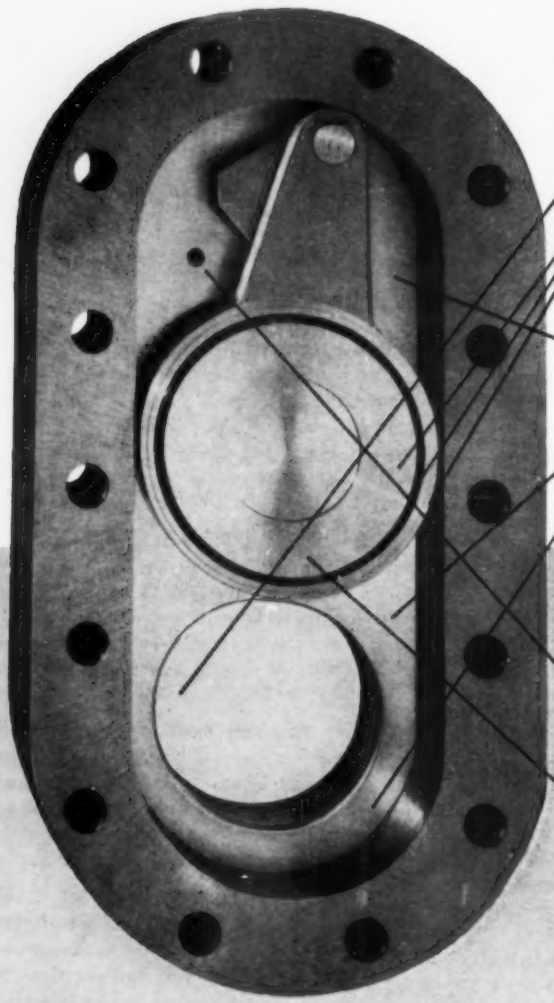
GROVE
Series
G-5

A new, with all the



Full Opening

Protected Seal-O-Ring Design—Unique Grove engineering places nitrile rubber O-rings and rugged metal seat rings on the gate, so that when in the open position, they are completely elevated away from foreign matter in the flow stream.

Continuous, Perfect Contact—Metal seat rings are firmly held in contact with polished and chrome plated body side plates to guarantee a continuous contact for scraping action through all gate positions. Squeegee action of the Seal-O-Rings maintains an immaculate surface on the side plates for perfect sealing.

No Lubrication—Ever

Bleeder Plug—Permits venting body cavity in closed position.

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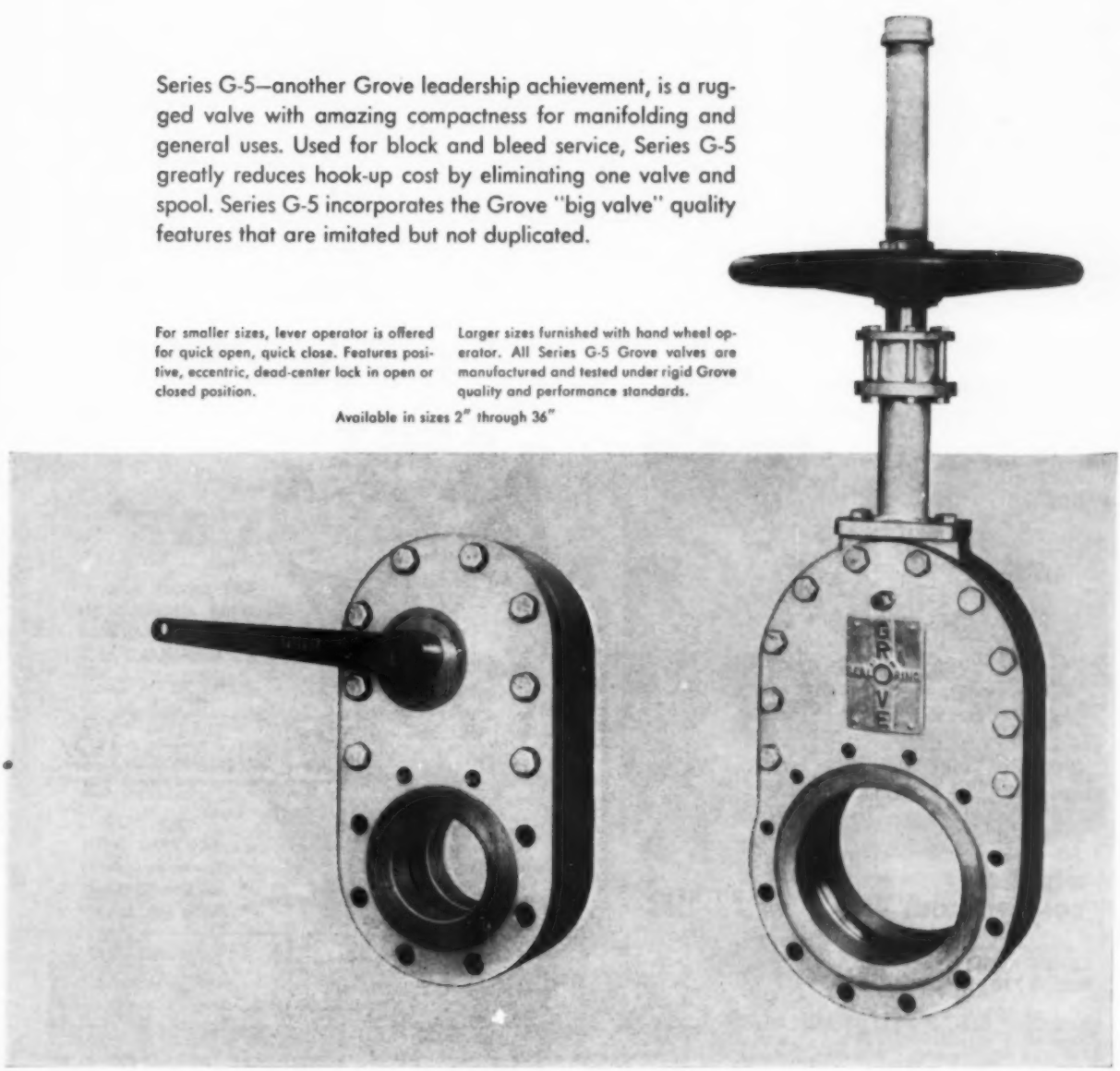
more compact valve proven GROVE features!

Series G-5—another Grove leadership achievement, is a rugged valve with amazing compactness for manifolding and general uses. Used for block and bleed service, Series G-5 greatly reduces hook-up cost by eliminating one valve and spool. Series G-5 incorporates the Grove "big valve" quality features that are imitated but not duplicated.

For smaller sizes, lever operator is offered for quick open, quick close. Features positive, eccentric, dead-center lock in open or closed position.

Larger sizes furnished with hand wheel operator. All Series G-5 Grove valves are manufactured and tested under rigid Grove quality and performance standards.

Available in sizes 2" through 36"



Trade Parade

Briggs-Weaver Machinery Company. Darrell Manley was named president, having served as executive vice president and general manager. He is also a director of the company.

Bucyrus-Erie Co. W. L. Litle has resigned as chairman of the board of directors, due to continuing ill health. He had been associated with the company for 32 years, primarily in executive capacities.

Succeeding Litle as chief executive officer is Robert G. Allen, president since December 1958. A. S. Puelicher, board member since 1945, succeeds Litle as board chairman. Newly named board members are Lawrence N. Murray and Victor C. Studley.

Maloney-Crawford Tank and Manufacturing Co. Personnel changes on the staff of Maloney-Crawford or Union Tank Co., which recently was acquired by the Tulsa firm and whose organization is being assimilated by Maloney-Crawford are Ed C. Kopp, formerly a division manager for M-C was named vice president with headquarters in Fort Worth. George W. Smith, formerly regional manager for Union, appointed division sales manager of the new organization with offices in Houston. Clint B. Warren, former M-C sales manager at Houston, named division sales engineer. Thomas Q. Mayes, former M-C assistant manager in Houston, promoted to branch manager there. Mac W. Miller, who was area sales engineer for Union, is division sales engineer in Dallas. Charles K. Gravis, engineer for Union at New Orleans, to division sales engineer with offices in Harvey, La.

Carroll T. Lancaster, formerly branch manager for Union, will have the same post at the M-C office in Harvey. James W. Young, branch manager for Union, named branch manager at Lafayette, La. Fran J. Hencke, area salesman for Union in Fort Worth, promoted to branch manager in Corpus Christi, Texas. Lee O. Weaver, Tulsa salesman, has been transferred to the Midland, Texas, office. H. R. Stoker, branch manager for Union, appointed branch manager at the Nocona, Texas, office. Merrill E. Bailey, formerly area manager for Union, promoted to sales supervisor and manager of sales in the Rocky Mountain area. Thomas E. Goodwin has been named to manage the firm's branch at Hobbs, N. M., while Fred C. McDaniel, former branch manager for Union, will head up the Farmington branch. Leonard L. Beck, formerly with Union, will be branch manager at Sterling. L. R. (Bob) Chester will retain his post of branch manager of the office in Oklahoma City. Jack J. Frese, former sales engineer for Union, named branch manager in Liberal, Kan.

Stearns-Roger Mfg. Co. Dr. Clifford W. Seibel, formerly assistant director of the U. S. Bureau of Mines in charge of helium activities, has joined the company as a full time consultant.

Shand and Jurs Company. Robert W. Blake has been elected vice president — sales, succeeding E. E. Jurs who retired. Blake was regional vice president in charge of the activities of the Eastern sales region.

United States Steel Corporation. William L. Hearne was appointed vice president — taxes. Leverne J. King was named vice president and assistant comptroller.

L. C. Simmons, administrative vice president — accounting, was appointed in line charge of accounting in the production and commercial groups of general operating divisions.

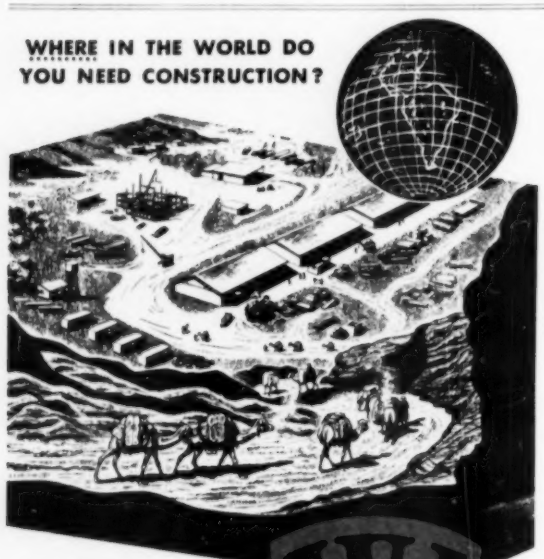
Reed Roller Bit Company. W. H. (Buddy) Armstrong was appointed regional sales manager for Oklahoma, Kansas and North Texas. T. H. Patterson is named division manager with headquarters in Oklahoma City. G. M. (Choc) Charleston was named Reed special salesman in Oklahoma City.

Republic Flow Meters Company, Rockwell Manufacturing Company. Benjamin L. Binford was named research coordinator of the development of instruments controls, valve operators and allied equipment at Republic with other divisions of the parent company. He had been vice president and chief engineer of Magnetrol Inc.

Solar Chicago, U. S. Industries, Inc. Robert L. Allen has been named president. Arthur Sternberg, who has been functioning as president of both Solar Chicago and Solar Permanent divisions of U. S. Industries, will concentrate his efforts on the latter division. Allen has been general sales manager of the Solar Chicago division.

United Geophysical Corporation. S. O. Patterson has transferred to the Gulf Coast-Midcontinent area including West Texas as area manager, headquartering in Houston, Texas. J. D. Rookus, present area manager in Houston, transferred to United Testing Laboratories in California.

U. S. Industrial Chemicals Co., National Distillers and Chemical Corporation. Ralph M. Knight was appointed a vice president. He will intensify U.S.I.'s long-range polyolefin development program and continue to direct the polymer service laboratory as well as to coordinate its efforts with other plastics activities within the company.



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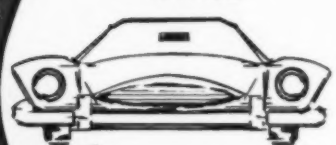

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▸ **Atlas Powder Company.** Arthur N. Green and Paul E. Stubbe were named as industry marketing assistants in Atlas Powder Company's chemical sales department.

▸ **Oil Metering and Processing Equipment Corporation.** E. E. "Dusty" Rhodes of Tulsa, Oklahoma, was named as sales and service representative for Oklahoma. He was formerly sales representative for Texstream Corporation.

▸ **Ideco, Inc.** E. F. (Gene) Shiels was named to vice president, marketing, W. M. (Bill) Marks to vice president, engineering, and Jack Hilder to domestic sales manager of Ideco, one of the Dresser Industries.

▸ **Nordberg Manufacturing Company.** Donald E. Byrnes was named to assistant sales engineer in the Dallas offices, engine division. He was formerly an assistant in the sales department.

▸ **American Meter Company** has acquired all of the outstanding capital stock of the Granberg Corporation of Oakland, California, manufacturer of tank truck, bulk plant and pipeline petroleum meters and pumps. Albert J. Granberg, founder and president, will be retained as a consultant.

▸ **Parkersburg Rig & Reel Company,** Division of the Parkersburg-Aetna Corporation. Craig M. Rowley was elected president. He previously served as executive vice president and general manager.

▸ **Minnesota Mining & Manufacturing Company.** John J. Verstraete Jr. was promoted to the newly-created position of director of communications, assuming responsibility for all publicity and communications services within the company.

▸ **Huffman Manufacturing Company.** H. G. (Hank) Loudenback, manager of public relations for The National Management Association with headquarters in Dayton, Ohio, has become advertising and sales promotion manager for Huffman Manufacturing Company.

▸ **W. C. Norris, Manufacturer.** R. W. "Cliff" Clifford has joined the sales force of W. C. Norris, division of Dover Corporation. He has been assigned to the West Texas sales division and headquartered in Midland, Texas.

▸ **Collins Radio Company.** Herbert J. Pyle was appointed director of service at the Cedar Rapids division. He was formerly vice president of Precision Instrument Laboratories in Glendale, California.

▸ **Lunkenheimer Company.** J. R. (Jack) Callaway was named representative in Dallas, Texas, covering North Texas and the Lubbock-Midland-Odessa-Hobbs territories as well as the Dallas-Fort Worth area.

▸ **Monsanto Chemical Company.** George B. Boon, mechanical engineer with the research and engineering division, was promoted to technologist.

▸ **Magnaflux Corporation.** General Mills, Inc. has acquired the corporation which will operate as a subsidiary without change of name. F. B. Doane, one of the founders and president, will retire from active management after 30 years, but remains as a consultant. Otherwise, the Magnaflux organization and personnel remain intact.

▸ **Tracerlab-Keleket.** William L. Kierstead was named assistant to the public relations manager.

▸ **Eastman Oil Well Survey Company.** H. John Eastman, president and founder of Eastman Oil Well Survey Company, announced the sale of the company to Phillip D. Arterburn, who has served the Eastman firm as financial adviser since 1943, will be the president, with Eastman continuing as chairman of the board and director.

William R. Boyd Dies

William R. Boyd Jr., 74, former president of the American Petroleum Institute and a nationally-known oil industry leader for three decades, died early November 6 in Teague, Texas.

Mr. Boyd received the Medal of Merit, the nation's highest civilian decoration in 1946, for his work as chairman of the Petroleum Industry Council for National Defense in World War II. He retired from the presidency of API in 1949.

Born at Fairfield, Texas, January 7, 1885, Mr. Boyd at 19 years of age, was admitted to the Texas bar by a special dispensation. He served two years as secretary to Congressman Scott Field in Washington, following which he returned to Texas to practice law in Teague.

Joining the API staff in 1920, just a year after the formation of the national oil trade association, Boyd served as assistant general secretary and counsel. He was elected executive vice president in 1929 and API president in 1941. In 1934 he received an honorary degree of Doctor of Laws from Saint Bonaventure College.

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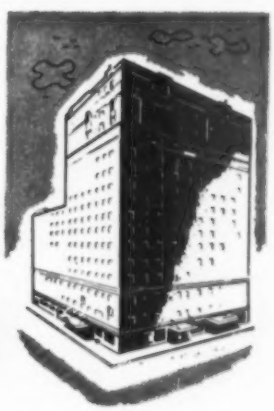

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Books To Read . . .

▸ **Oil and Petroleum Year Book, 1959,** *compiled and published by Walter E. Skinner, 20 Copthall Avenue, London, E. C. 2, England. Pages, 800. Price, $7 (Post Free).*

Mr. Skinner's compilation, in its 50th edition, gives complete and up-to-date particulars of more than a thousand British, American, French, Canadian, and other oil companies operating in all parts of the world, and covering all branches of the industry. A list is also included of 730 names and addresses of managers, engineers and agents and the companies in the book with which they are connected.

A table is included which shows annual world production of crude oil and natural gasoline for the period 1949 to 1958. The author has also provided colored maps of "Middle-East Oilfields" and "Trans-Canada Natural Gas Transmission System."

A "Buyer's Guide" section comprises 2000 headings of manufacturers of oilfield and refinery equipment and accessories.

▸ **Our Mineral Resources,** *by Charles M. Riley. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York. Pages, 338. Price, $6.95.*

This book is unique in that it offers an elementary approach to a subject most often taught at a college senior or graduate level. With a minimum use of scientific terminology, it presents a great amount of scientific theory and useful fact. The book summarizes the most modern knowledge about where and how our valuable mineral resources are formed by nature.

Section 2 is on non-metallic minerals, including petroleum. The author is a research geologist for Humble Oil and Refining Company. Earlier he was assistant professor of geology at the University of Nebraska, where he wrote this volume. He holds a doctorate from the University of Minnesota.

▸ **Tatlock's 4 Corners and Rocky Mountains Petroleum Directory.** *Published by Tatlock's, Inc., Majestic Building, Denver, Colorado. Pages 362. Price, $6.50.*

The fourth annual edition of this directory is a compilation of all companies and personnel operating in the Four Corners-Rocky Mountains area. Feature of the book is its cross-indexing: The names of the key personnel of the listed companies — landmen, geologists, purchasing agents, drilling superintendents, toolpushers, production superintendents, engineers, office managers, foremen, etc. — are included in a single alphabetical list.

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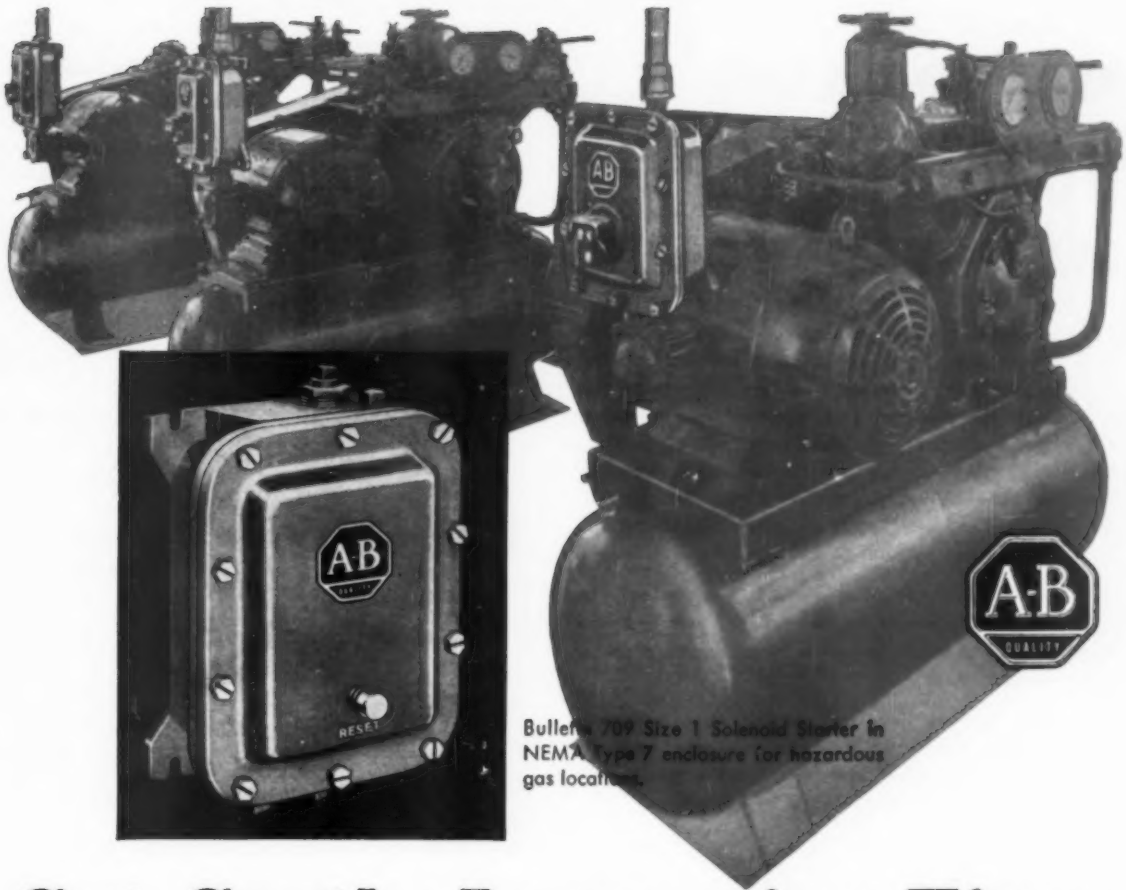

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In any role or application, MANI-FLO valves may be hydraulically, electrically or diaphragm controlled and sensed by liquid levels, pressures, temperatures, times or differentials of these.

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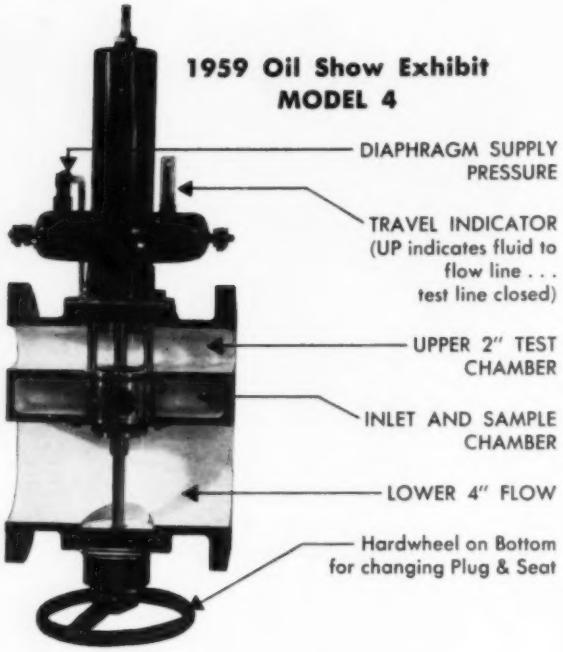
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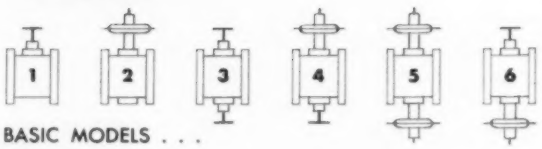

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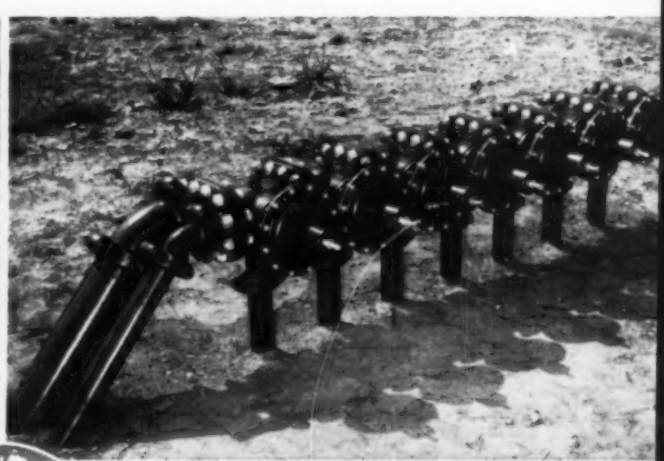

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With Field Engineered Units TODAY BACKED BY Parts and Service Tomorrow!

- Cabot quality pumping units with field proven low maintenance.
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Beam balanced units 3,000 to 11,000 lbs. capacity.
Adjustable crank units 7,000 to 32,000 lbs. capacity.
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OIL FIELD PUMPING EQUIPMENT
CABOT
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GARRETT OILFIELD AUTOMATION

...IS THIS SIMPLE

Complicated electronics is fascinating in the laboratory but has no place on an oil lease. That is why Garrett, with years of oilfield know-how, developed a simplified and highly standardized system of automation for the entire well complex. Tested and proved in the field, Garrett equipment, which utilizes commercially available components, is now obtainable from off-the-shelf stocks.

Field units can be operated or restored to service by any pumper without specialized electrical training. The system uses standard 110 volt alternating current, with plug-in type replaceable elements.

Garrett automation covers every step of production control: wellhead flow, well test programming, LACT, recording, communications . . . plus home office reports and machine records.

Completely compatible with existing equipment and control systems, Garrett offers the additional advantage of building block design. You can start with the simplest well control system — then add further automation or expand as needs arise. When production justifies, the automation of the entire well complex can be completed without changing existing portions already automated.

Let a Garrett automation engineer consult with you on your next production automation program. He will explain how Garrett offers complete turn-key installations . . . call or write today.

USI

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DIV. OF U. S. INDUSTRIES, INC.

P. O. Box 2427, Longview, Texas

Garrett automation systems provide optimum production efficiency . . .

. . . from wellhead . . . to field station . . . to home office records unit.

Of Things To Come . . . In Oil

SUPREME COURT RULING in the small-tract hassle may be the finale to the current legal debate over permits granted in Texas to drill on "town-lot" tracts. The Texas Supreme Court has upheld two such permits granted by the Railroad Commission, one for a well on a 0.48-acre plot in the Port Acres gas field of Jefferson County, Texas. Opponents of the ruling contend that such permits lead to drainage of reserves underlying neighboring leases, and that such drainage amounts to confiscation of property without due process of law, in violation of the federal constitution.

TIGHTENING UP ON WEST COAST IMPORTS by the federal government is seen as a probability for the January-June allocation period in 1960. Starting with this period, plans now in the mill will designate imports of crude from Canada into the Pacific Northwest as part of District 5 "domestic supply." Such imports from Canada have almost tripled since import restriction controls were imposed nearly a year ago. If the supply-demand balance in District 5 remains unchanged in the coming allocation period, the total crude import allowable for the West Coast may be cut from 233,000 bbl per day presently allowed to 180,000 bbl per day for January-June.

LOSS OF SKILLED RIG CREWS will be one of the greatest and most long-lasting hardships suffered by drilling contractors as a result of the past and present depressed financial situation of the contracting business. Warren L. Baker, AAODC executive vice president, points out that low rig activity has lengthened the period of unemployment for rig crews. Profit losses have cut wage advances for drilling crews. Result: Rig personnel have been drifting into other industries for steadier work, better living conditions, and often at the same or better wages.

OFFSHORE TEXAS ACTIVITY WILL INCREASE as a result of Standard Oil Company of Texas' recent completion of the first commercial oil well in the Outer Continental Shelf off the state's coast. Federal 52-#2, located in the High Island area in the Gulf of Mexico about 36 miles northeast of Galveston, flowed at the rate of 228 bbl per day from the Lower Miocene sand through perforations at 8520-26 ft. A 5-well platform is being constructed at the site for further development of the field. Standard of Texas completed the first commercial oil well in the Texas tidelands off Padre Island in 1954.

P G A C

Provides EVERY TYPE of WELL PERFORATING —Proven BETTER in toughest wells!

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Atlas Bulldog Bullet Gun Perforating
Jet Gun Perforating
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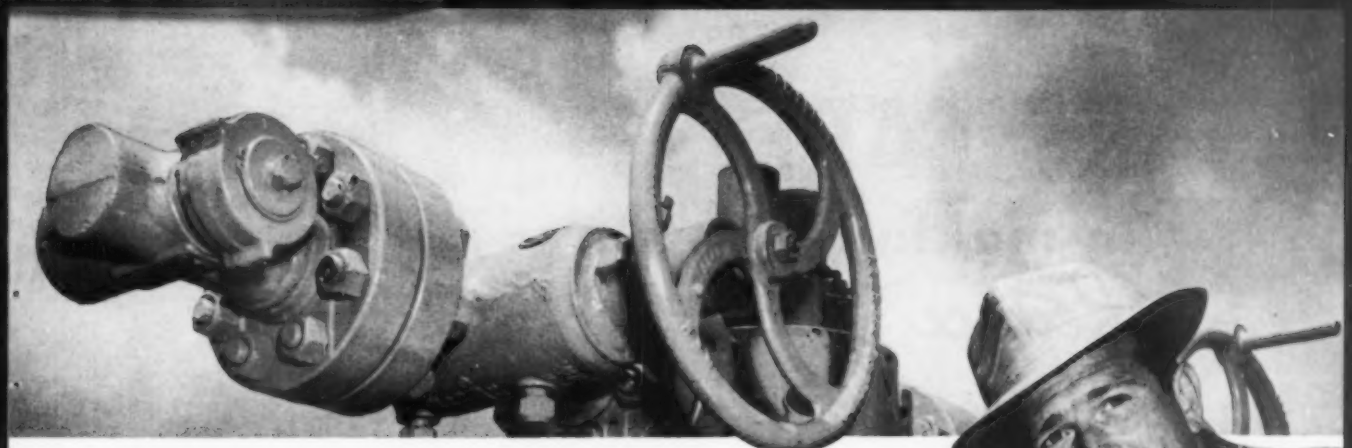
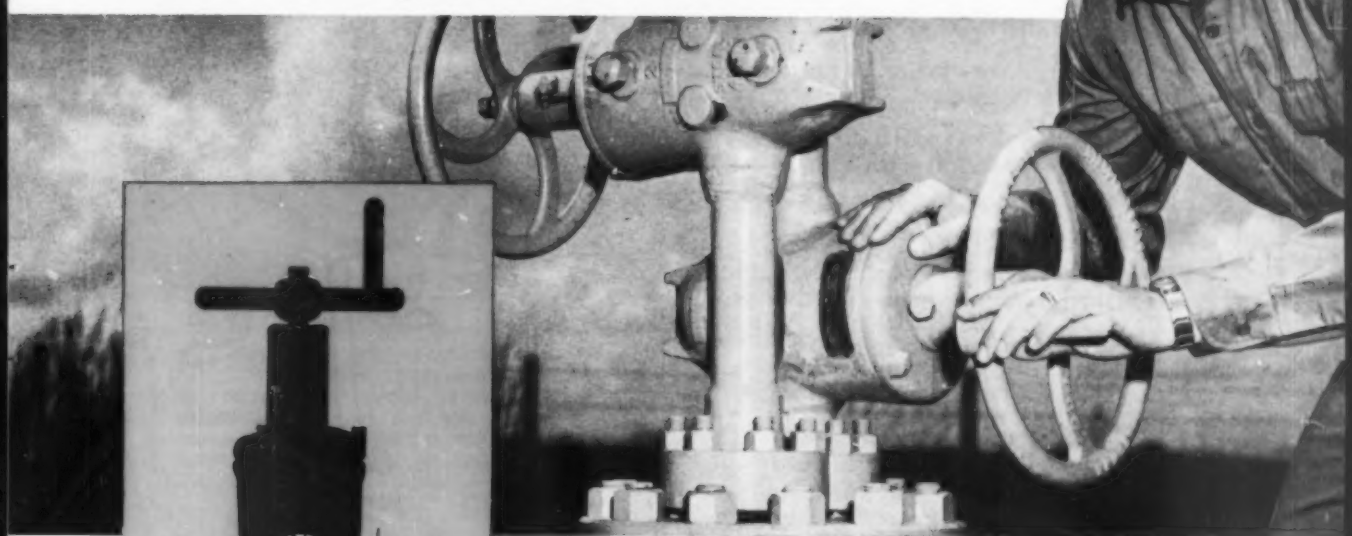
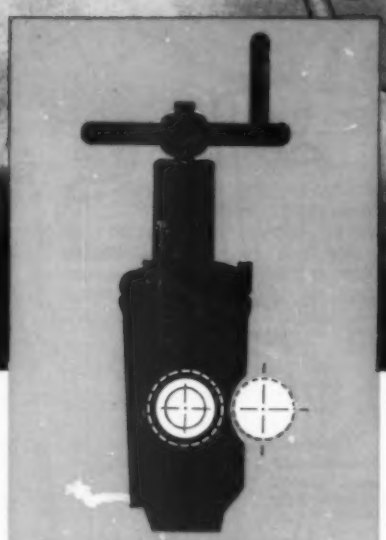
GERMANY — Atlas Deutsch-Amerikanische Oilfelddienst, G.m.b.H. U.S.A. — PGAC Development Company



"No other valve gives such a perfect seal"





W-K-M Recessed Body Valves feature through-conduit gate construction, pressure seal bonnets, super-finished stems supported on roller bearings — and can be overhauled on-the-line.

Sizes: 1½", 1¾", 2", 2½" and 3". **Working Pressures:** 2000 through 5000 pounds.

PRODUCT OF W-K-M's *Creative Engineering*

W-K-M® Recessed Body Valves for Multiple Completions

No other valves give you such tight sealing, such dependable control.

W-K-M's Controlled Force Seating creates an initial bubble-tight seal between the gate and Teflon inserts. As the gate assembly expands, a tight metal-to-metal seal is achieved. Result: a perfect *Double Tight Seal* without body or seat lubrication.

Next time — and every time — specify W-K-M! Recessed Body Valves are available for dual and triple completions. *At leading supply stores everywhere.*

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W-K-M

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P. O. BOX 2117, HOUSTON, TEXAS

5906-R

Norris Suggests:

TAKE CARE

in making-up string

Reduce your pumping Costs

Helpful Hints

- Rods in singles only should be tailed into the derrick for running and should be handled with special care, avoiding bending, and contact with ground, walk, or ramp.
- Do not remove thread protectors until rods are hanging in derrick.
- After removal of protector, "dope" or lubricant should be applied to pin thread.
- Use proper wrenches in making-up rod joints, applying recommended torque.
- Use torque type wrenches if available. Never hammer the box in making-up.
- Elevators, hooks, and wrenches should be kept in good operating condition, clean, free of scale or paraffin, and with good working surfaces at points of contact.
- Full make-up torque should be attained after contact of shoulder and face in each joint make-up.

Norris supplies the right rod... give it the right care!

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SUCKER RODS
POLISHED RODS - COUPLINGS

W. C. NORRIS, MANUFACTURER
DIVISION OF DOVER CORPORATION
TULSA, OKLAHOMA

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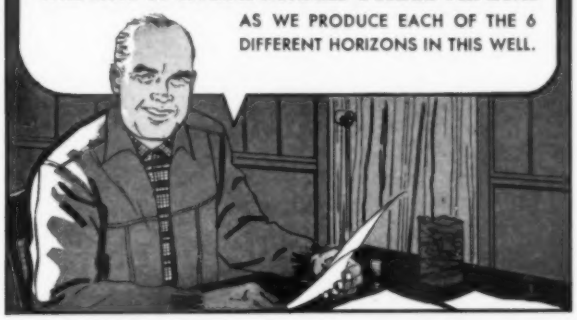
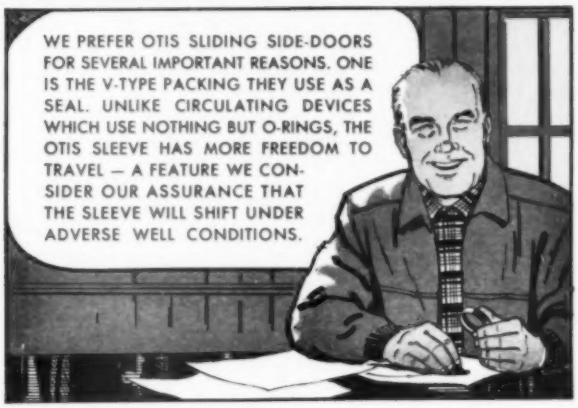
Buy From *Your* NORRIS Distributor

OTIS SLIDING SIDE-DOOR EQUIPMENT
WILL SAVE US SEVERAL HUNDRED DOLLARS PER ZONE

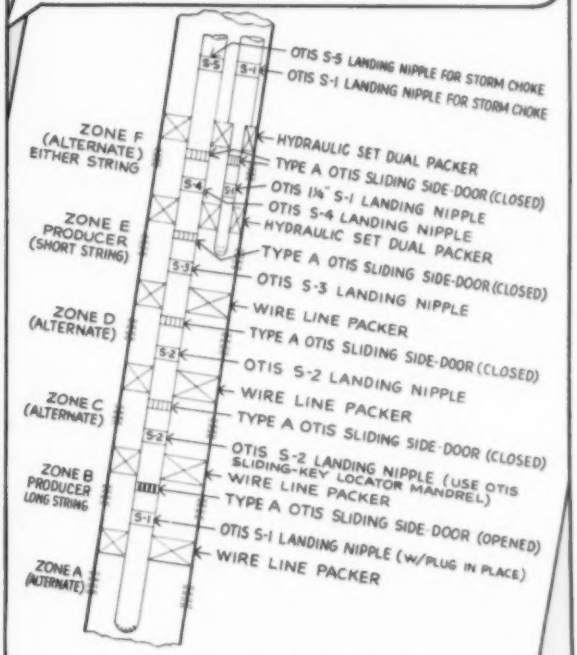
AS WE PRODUCE EACH OF THE 6 DIFFERENT HORIZONS IN THIS WELL.




WE PREFER OTIS SLIDING SIDE-DOORS FOR SEVERAL IMPORTANT REASONS. ONE IS THE V-TYPE PACKING THEY USE AS A SEAL. UNLIKE CIRCULATING DEVICES WHICH USE NOTHING BUT O-RINGS, THE OTIS SLEEVE HAS MORE FREEDOM TO TRAVEL — A FEATURE WE CONSIDER OUR ASSURANCE THAT THE SLEEVE WILL SHIFT UNDER ADVERSE WELL CONDITIONS.

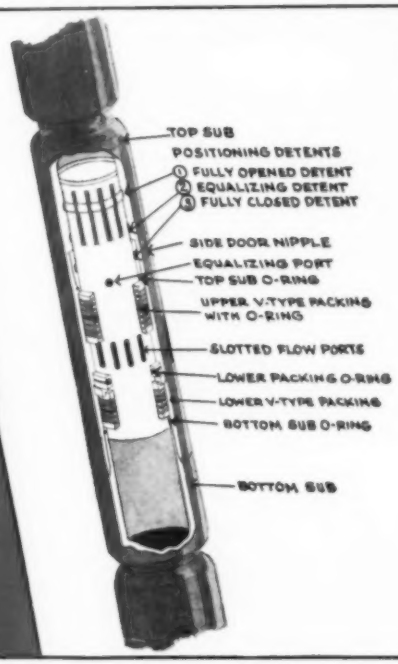
2

ADD TO THAT THE THOUSANDS OF DOLLARS WE SAVED BY DRILLING ONLY ONE WELL TO PRODUCE THESE 6 FORMATIONS AND YOU'LL SEE WHY WE'RE SOLD ON MULTIPLE-ZONE WELLS AND OTIS SLIDING SIDE-DOOR EQUIPMENT. HERE'S A DIAGRAM OF THE WELL.


OTIS S-5 LANDING NIPPLE FOR STORM CHOKE
OTIS S-1 LANDING NIPPLE FOR STORM CHOKE
ZONE F (ALTERNATE) EITHER STRING
HYDRAULIC SET DUAL PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS 1¼" S-1 LANDING NIPPLE
ZONE E PRODUCER (SHORT STRING)
OTIS S-4 LANDING NIPPLE
HYDRAULIC SET DUAL PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS S-3 LANDING NIPPLE
ZONE D (ALTERNATE)
WIRE LINE PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS S-2 LANDING NIPPLE
ZONE C (ALTERNATE)
WIRE LINE PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS S-2 LANDING NIPPLE (USE OTIS SLIDING-KEY LOCATOR MANDREL)
ZONE B PRODUCER LONG STRING
WIRE LINE PACKER
TYPE A OTIS SLIDING SIDE-DOOR (OPENED)
OTIS S-1 LANDING NIPPLE (W/PLUG IN PLACE)
ZONE A (ALTERNATE)
WIRE LINE PACKER

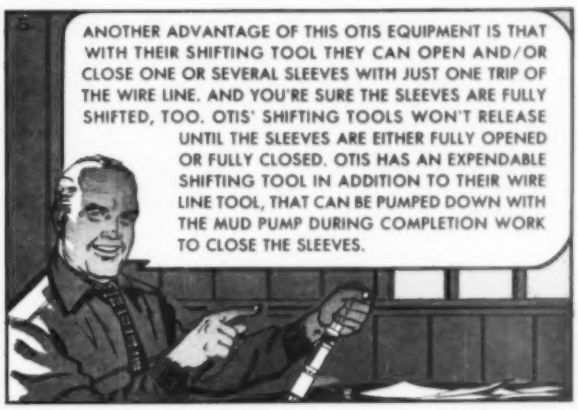
3

THEN THERE'S OTIS' VERTICAL SLOTTED PORT DESIGN. THIS GIVES OTIS SLIDING SIDE-DOORS MAXIMUM STRENGTH—AND ACTS TO PREVENT DISTORTION OF THE TOOLS AS THEY ARE SUBJECTED TO THE STRESS AND TORQUE OF A PRODUCTION STRING. HERE'S A DETAILED DRAWING OF THE TYPE A OTIS SLIDING SIDE-DOOR. NOTICE THE DESIGN ADVANTAGES.



5

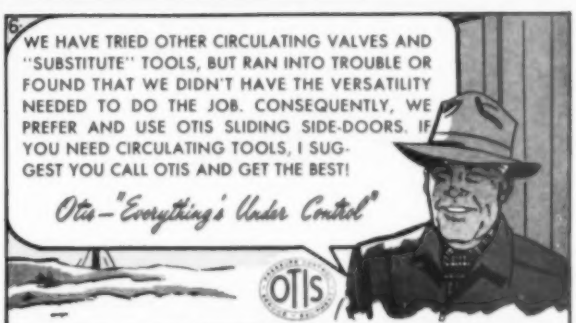
ANOTHER ADVANTAGE OF THIS OTIS EQUIPMENT IS THAT WITH THEIR SHIFTING TOOL THEY CAN OPEN AND/OR CLOSE ONE OR SEVERAL SLEEVES WITH JUST ONE TRIP OF THE WIRE LINE. AND YOU'RE SURE THE SLEEVES ARE FULLY SHIFTED, TOO. OTIS' SHIFTING TOOLS WON'T RELEASE UNTIL THE SLEEVES ARE EITHER FULLY OPENED OR FULLY CLOSED. OTIS HAS AN EXPENDABLE SHIFTING TOOL IN ADDITION TO THEIR WIRE LINE TOOL, THAT CAN BE PUMPED DOWN WITH THE MUD PUMP DURING COMPLETION WORK TO CLOSE THE SLEEVES.



6

WE HAVE TRIED OTHER CIRCULATING VALVES AND "SUBSTITUTE" TOOLS, BUT RAN INTO TROUBLE OR FOUND THAT WE DIDN'T HAVE THE VERSATILITY NEEDED TO DO THE JOB. CONSEQUENTLY, WE PREFER AND USE OTIS SLIDING SIDE-DOORS. IF YOU NEED CIRCULATING TOOLS, I SUGGEST YOU CALL OTIS AND GET THE BEST!

Otis—"Everything's Under Control"



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CF&I Seamless Casing and Tubing Service

provides more than quick delivery

The giant steelman represents CF&I's ability to manufacture quality steel products for the petroleum industry, *and* to provide customer service backed up by intimate knowledge of oil country requirements. CF&I Seamless Casing and Tubing is an excellent example. Here's why:

CUSTOMER SERVICE: In addition to quick delivery, CF&I has qualified personnel who are ready to work with you on your Casing and Tubing problems. These men are specialists and know the problems common to the Petroleum Industry.

QUALITY CONTROLS: Mill controls are used to assure *straight* steel pipe with *precision* threading. Straight pipe is essential for smooth drilling operations. Precision threading, which minimizes galling, provides strong joints that prevent leakage and withstand high internal and external pressures.

CF&I Seamless Casing and Tubing is made to meet API STD 5A specifications, and is available in sizes 2⅜" through 9⅝" O.D. Let us serve you.

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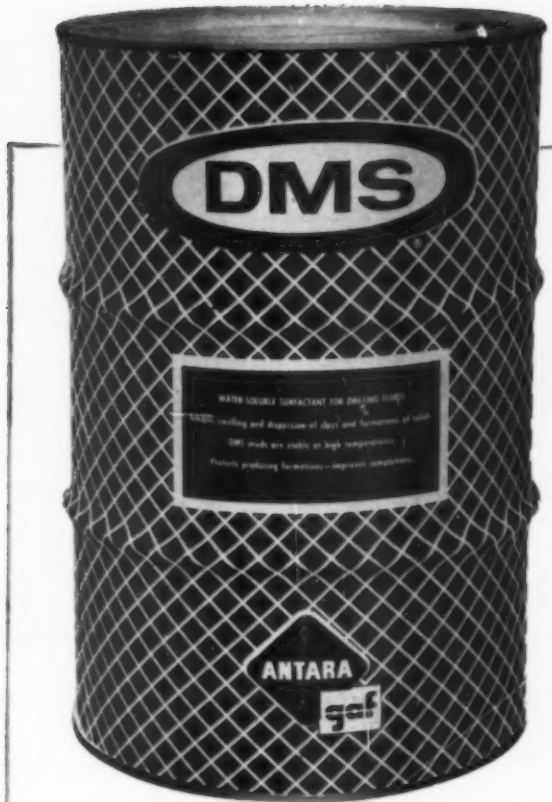


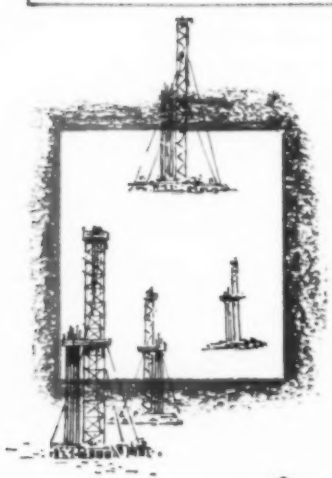
DMS®

for

STABLE DRILLING MUDS

IN LOW-SOLIDS MUDS

IN WEIGHTED MUD SYSTEMS



DMS is a water soluble nonionic surfactant for use in all drilling muds.

DMS muds are stable to high temperature, salt and anhydrite.

DMS muds have been used as drilling fluids with weights up to 22 ppg and with temperatures up to 450°F.

DMS reduces consumption of fluid loss additives and improves their efficiency in all systems, even saturated salt muds.

DMS muds minimize dispersion of drilled solids and reduce maintenance and watering back.

DMS, packed in distinctive red checked drums, is available in all drilling areas.

Consult your local Baroid or Magcobar Dealer for product know-how and Service.

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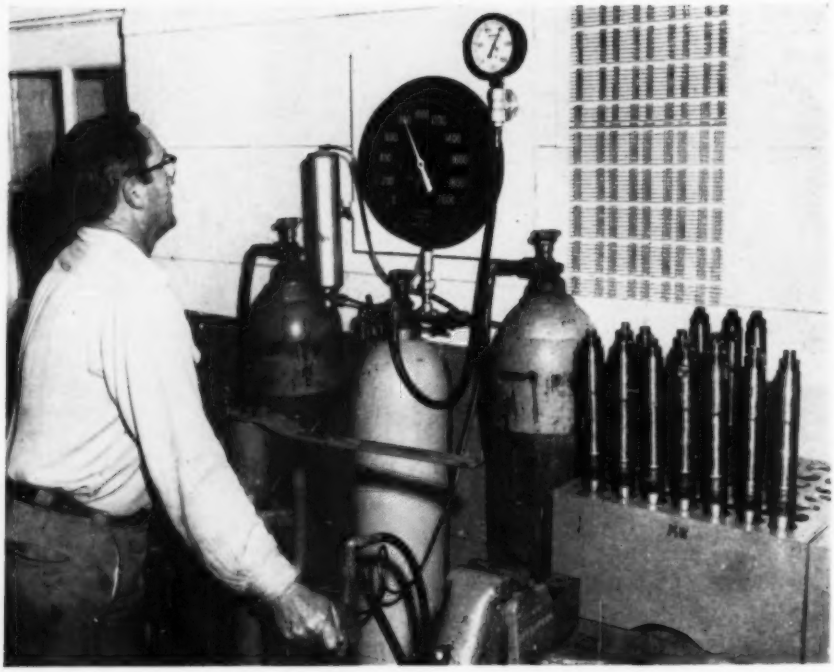
Typical A Valve Test Case History — *No Pressure Loss*



TYPE A FLOW VALVE

GUIBERSON'S

Type A Flow Valves are Proved Perfect Before Shipping

Every Guiberson flow valve is pressured, then put through periodic opening and closing tests to assure operational efficiency. Each valve is electronically checked with a leak detector so sensitive it detects leaks as small as one ounce per hundred years. Guiberson valves are known to be perfect before shipping.

This unique method of quality control is the reason why Guiberson flow valves have built-in reliability.. costly pulling jobs for valve repairs are cut to the minimum. It's the reason why experienced operators say these valves have the lowest number of returns in the industry.

Guiberson's Type A Control Valves produce continuous or intermittent flow with only surface adjustment. Designed and engineered for superior performance, with tungsten carbide ball and seat that last for years. Corrosion and erosion resistant construction throughout — no rubber, no plastic, no O-rings to deteriorate.

Guiberson's Type AW Valve Is Available for Wire Line Installations. The Type AW, with integral check valve and special mandrel, lets you run in and retrieve on wire line.

THE GUIBERSON CORPORATION

ESTABLISHED 1919 — DALLAS, TEXAS U. S. A.

another
TRETOLITE SERVICE
report

eliminates filter channeling, oil deposit, iron sulfide

FLUDEX* WATER FLOOD ADDITIVE SOLVES FILTER MAINTENANCE PROBLEM

Inspection of the filtering elements in a mid-continent water-flood operation revealed that these elements rapidly lost their efficiency due to oil clogging, iron sulfide deposits, and channeling in the filtering media.

FLUDEX ADDITIVE USED TO BACKWASH FILTERS

To correct these difficulties, the filters were backwashed with FLUDEX Water Flood Additive in a 3-step application:

1. The filter was inspected and found to contain a large hole in the graded anthracite media and a heavy coating of oil.

2. Allowing water to stand on the media to a depth of 6-8 inches, 10 gallons of FLUDEX Water Flood Additive were introduced into the filter. This was allowed to soak for about 20 hours before the normal backwashing operation was begun. (Backwashing effluent showed substantial quantities of oily material and iron sulfide.)

3. The backwashing was continued until the backwash effluent ran clear.

SUCCESSFUL RESULTS NOW PART OF MAINTENANCE PROGRAM

The inspection plate was then removed and visual inspection made. There were no holes, or channels, in the filter media; it was also free of oil and iron sulfide. Results were so satisfactory that all filters in this water-flood operation now undergo regular FLUDEX treatment as a routine maintenance measure.

Find out how FLUDEX can fit into your operation. Ask the Man in the Red Car. Or write to . . .

TWF 59-2

*FLUDEX *is a registered trade-mark of Petrolite Corporation*

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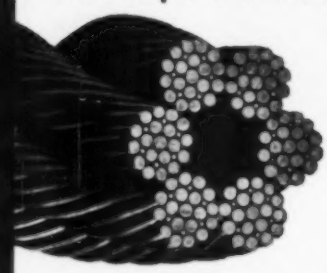
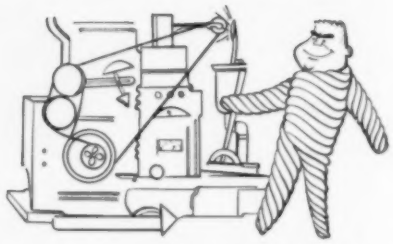
Tuffy® Wire Rope Tips

To Get The Most for What You Pay
Be Sure You Get Correct Rope Lay

Wire Rope is a "Machine" of Moving Parts





...and Every Part Must Fight Destructive Forces

A "look inside" a piece of wire rope reveals a precision-designed assembly of working parts. The parts are core, wire and strand. They are subjected not only to external and internal stresses and strains, but also to heavy surface pressures and abrasions. All these forces may be sustained while the rope is running under very high speeds, and abruptly changing direction of motion. That's why different uses require different constructions of wire rope.

Extra Strength Alone is Not Enough... Wire Rope Must Be BALANCED

Sometimes extra strength is heavily stressed in advertising wire rope. While strength is important wherever wire rope is used, it is not the only important property. And there are cases where too much strength is a liability.

For example, manufacturers of scrapers have designed their equipment to take certain loads. These loads are controlled by, or subject to the ultimate strength of the rope. Larger ropes with higher strength do not break. but *the equipment itself begins to break up.*

Depending on your use of wire rope, the "job prescribed" Tuffy Special Purpose Ropes give you the RIGHT BALANCE of strength, toughness, flexibility for greatest efficiency and longest service life.

Tuffy Balanced Standard Rotary Line helped drill the world's deepest well—Wildcat I-EE in Pecos County, Texas. This rotary line is famous for top performance in use with standard rigs in any formation. It also does an outstanding job with jacknife rigs in deep drilling beyond 6000 feet.

Tuffy Balanced Jacknife Rotary Line: Made to the special needs of jacknife rigs drilling to 6000 ft. Has extra strength, with greater flexibility to move at higher speeds over the smaller sheaves and drums of jacknife rigs, and to give better reeving and spooling.

Tuffy Balanced Slings & Hoist Lines This team has made a name for cutting hoisting and downtime costs in all types of materials handling. Tuffy Hoist Line gives the balanced combination of strength and flexibility needed for a longer running rope. Tuffy Slings are made of an extra flexible, high-strength machine-braided fabric that smooths out uninjured after knotting or kinking.

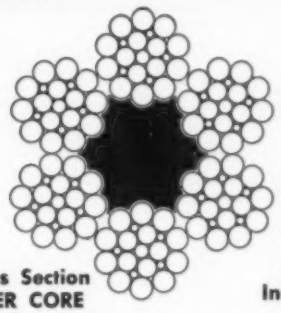
FREE!

Complete handbook of wire rope use in oil field service

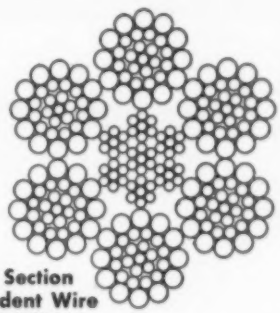
Latest, most complete information ever compiled on the subject in one publication. Shows the various rope constructions used by the oil industry, and gives full data tables on each. Includes (in their entirety) "A.P.I. Specifications for Wire Rope" and "A.P.I. Recommended Practice on Application, Care and Use of Wire Rope for Oil Field Service."

Write Union Wire Rope Corporation, 2106 Manchester Ave., Kansas City 26, Mo. Specialists in high-carbon wire, wire rope, braided wire fabric and stress relieved wire and strand.

Let's Take A Look at the CORE of Wire Rope



Cross Section
FIBER CORE

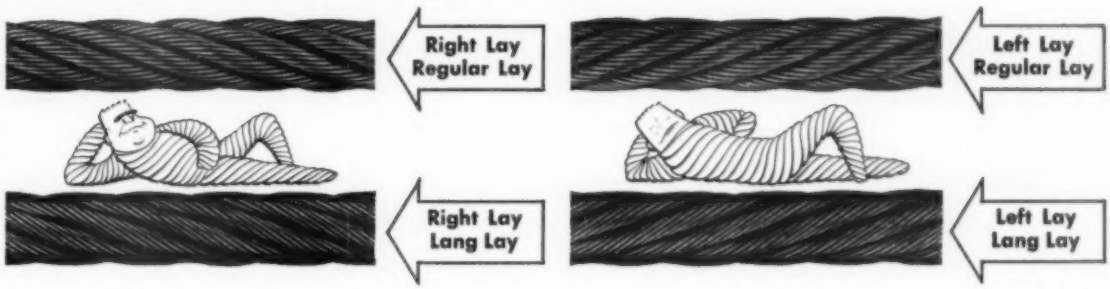


Cross Section
Independent Wire
ROPE CORE

It's either fiber or steel. Fiber cores are usually made from sisal, java, manila or combination of such hard fibers. Steel cores are either wire strand or an independent wire rope core, which amounts to a separate wire rope. The core serves as a base for the strands, keeping the rope in round shape and providing clearance between the strands for freedom of movement.

It's easy to see why wire rope is a "machine"—deserving the same care in selection and use that is given to any fine machine.

Which Lay of Wire Rope is Right for What Use



The "lay" of a rope is described in directional terms. It's a **right lay** when the strands pass from left to right across the rope. It's **left lay** when they pass from right to left.

Wire rope is also either **regular** or **lang** lay. In the **regular lay** the wires are laid in strands opposite in direction to the lay of the strands. In the **lang lay** rope, the wires are laid in the strands in the same direction as the lay of the strands.

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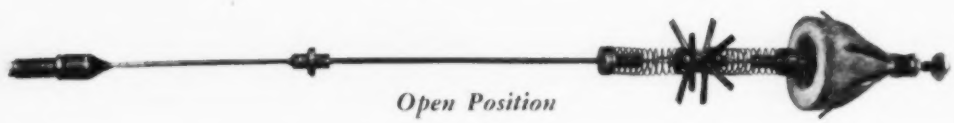
4

Another Through-Tubing Tool from Welex

Through-Tubing BRIDGE PLUG

Closed Position

Bridge Plug Case



Open Position

Welex has added a Through-Tubing Bridge Plug to its list of through-tubing completion services, now the most complete in the industry. The Welex Through-Tubing Bridge Plug offers these trouble-free, time-saving advantages:

1. POSITIVE SEAL. Design of the tool assures a positive seal. The Welex plug provides a base for the cement, holding it firmly in place until it sets.
2. ENTIRELY CASED. The Welex plug is entirely cased as it travels downhole, eliminating chances for premature setting or malfunction due to damage.
3. ONLY ONE RUN REQUIRED. Cement is carried into the hole and dumped on the same run the plug is set, reducing rig time or the period the well is off-production.
4. SMALL TOOL O.D. The OD of the Welex plug is 1-11/16", permitting use through standard 2" tubing.
5. REMOVABLE. The Welex plug may be removed from the well with acid. It is all aluminum except for the slips and packer springs.

Welex proudly adds the Through-Tubing Bridge Plug to its list of through-tubing completion tools which are already standards of the industry. Other through-tubing services which help make Welex the complete wireline service company include:

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$$* E = \tfrac{1}{2}(m_1 v_1^2 + m_2 v_2^2 + m_3 v_3^2) = \tfrac{1}{2} M_r v_r^2$$

Maximum Horsepower at Minimum Operating Cost

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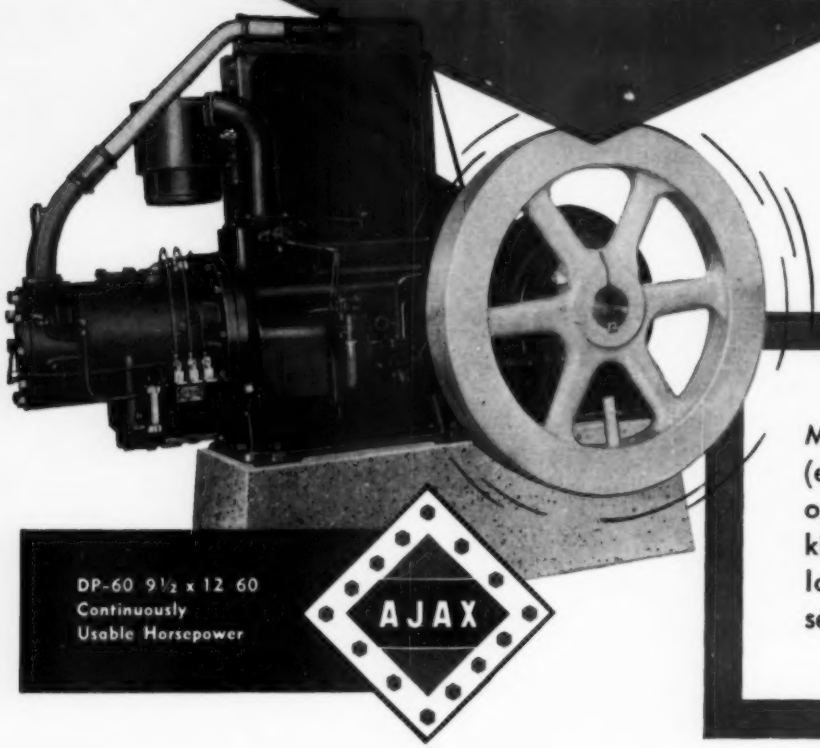

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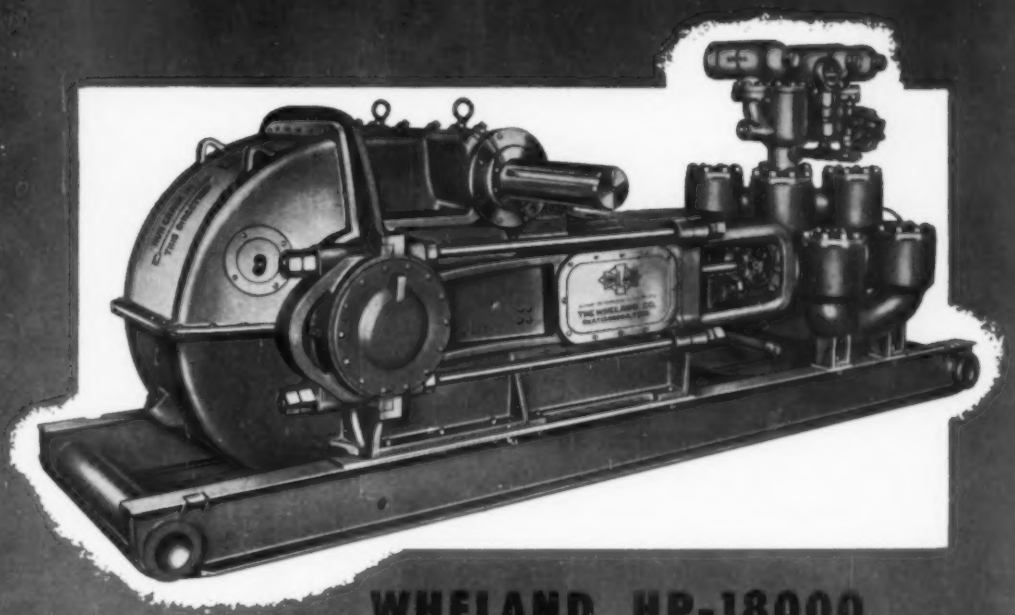

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BAKER ROTO-VERT CASING SCRAPER

provides a clean, safe "working surface"—removes cement sheath, scale and burrs.

The brittle cement sheath, *indicated in blue,* always remains after the drill bit has passed, and can prevent slips of pack-off tools from gripping properly. Or trapped between the casing and packing element, this cement sheath can crack under compression and cause pressure-leaks. Expensive failures of other tools also can be traced to obstructions, such as, *embedded bullets, perforation burrs, rust, mill scale, paraffin, and the like.*

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WHAT THE BIT FAILS TO REMOVE CAN PROVE EXPENSIVE!

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Shop made and commercial . . .

Workover and Servicing Tools for Slim Hole Completions

Shop made and "off-shelf" tools now offer greater flexibility and safety when working inside 2⅞-in. casing

William D. Shannon
Equipment Engineer
Stekoll Petroleum Corporation
Dallas, Texas

IT IS NO MORE DIFFICULT TODAY to work inside nominal 2½-in. casing than inside conventional casing sizes. Of course, slim hole techniques have not yet become conventional and standardized throughout the industry, but with the proper tools and carefully planned procedures, slim hole operations present no unique problems.

The field of slim hole completions is obviously too large to be covered in one short discussion. Probably the most-asked question about slim hole completions is, "How do you work inside the 2⅞-in. pipe?" We will attempt to outline here some of the tools and procedures that are employed by Stekoll Petroleum Corporation to make slim hole servicing and workover a safe and profitable operation.

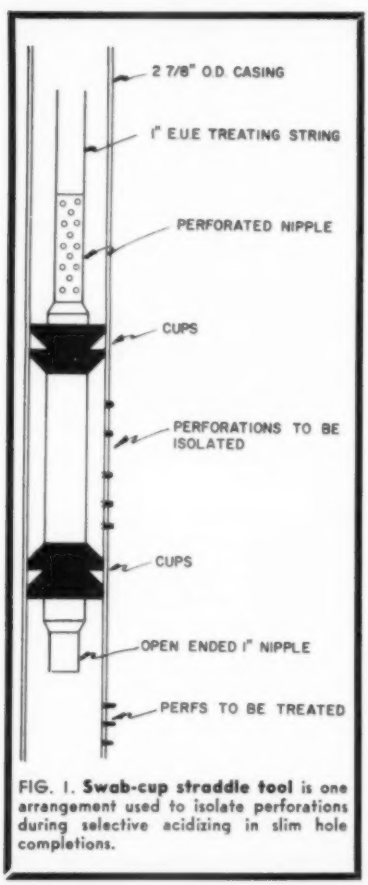


FIG. 1. **Swab-cup straddle tool** is one arrangement used to isolate perforations during selective acidizing in slim hole completions.

Swabbing

Let us begin with a well in which 2⅞-in. OD casing has been set to a depth of, say, 8500 ft, such as we might find in our Panhandle operations. This hypothetical well has been perforated and we are ready to swab for an oil test prior to performing a fracture treatment.

The swab string is made up as follows and run into the hole. Swab line of from 7/16 to ⅝-in. is hooked to a 1⅜-in. OD swivel socket with a safety shear pin designed to release at 10,000 lb tension. Below this is 18 to 20 ft of 1¼-in. OD sinker bars with standard 15/16-in. pins. Following these come the 36-in.-stroke jars and the swab mandrel with swabs.

Various swabs may be used depending upon the hole conditions. Under the assumed conditions, we would probably be pulling a tandem disk-type swab for testing. After fracture treatment and before clean-up, we would again use this same swab configuration, but only until the first sign of fracture sand appeared. At this point the swab would be changed to a single-swab arrangement the design of which, we feel, allows for more free passage of sand. The use of only one swab is important in order to reduce the tendency of the swab and mandrel to stick under sandy conditions.

When this single disk-type swab arrangement will no longer pick up fluid and sand from swabbing depth and further swabbing is desired, an aluminum mandrel with safety shear pin is run with only one cup-type swab in place. Should this swab stick, the pin can be sheared and an acid or caustic solution used to eat up the mandrel, permitting removal or milling up of the cup with fishing tools.

Another swab arrangement which may be used requires extreme caution. When the hole has not yet been perforated and is positively sand-free, we on occasion swab the hole dry with a cup-type swab. Generally speaking, however, it is safest to use the disk-type swab in all cases except where a cup is absolutely necessary, in which case an expendable mandrel should be used as a safety precaution.

Selective Acidizing

Let's look at a case such as might be found in our Panhandle or Canadian operations where we have multiple sets of perforations open and want to acidize them selectively. Obviously, some type of straddle tool or isolation packer arrangement is required.

Field design. Until recently, the solution to this problem was to make up a series of cup-type packers below a 1-in. nominal treating string (Fig. 1). A perforated 1-in. nipple was run immediately above the upper set of two cups which were run looking up the hole. A sufficient length of plain 1½-in. tubing to span the perforations to be isolated was run below these cups. Another set of cups looking down the hole followed this blank joint. The lower end of the tool consisted of a swage and a 1-in. nipple, open-ended.

When the tool was positioned in the hole to cover the upper perforations, the squeeze was performed down the 1-in. tubing. Acid pressures above the upper set of cups and below the lower set of cups were essentially equal. This resulted in a minimum of unbalanced force across the tool, with the net axial force along the 1-in. string being the product of the treating pressure and the cross-sectional area of the 1-in. tubing. In some cases, treating pressures and bouyancy have combined sufficiently to require that the 1-in. treating string be clamped and chained down at the surface.

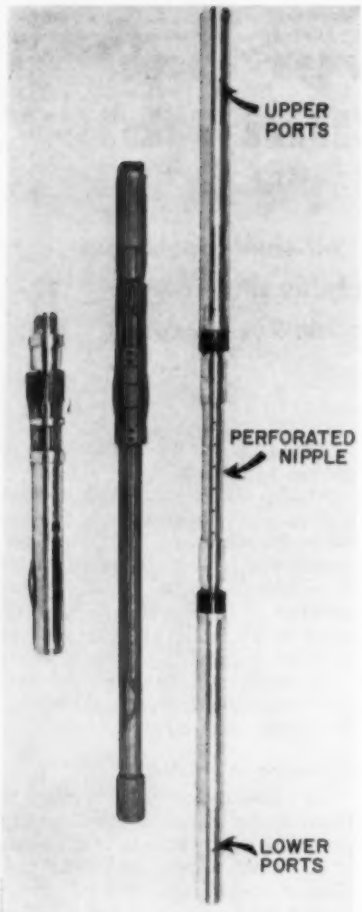


FIG. 2. **Commercial straddle tool** (right) can be used with optional lower slip arrangements: Insert pump anchor with rubber and upper head removed (center), or a slip and J-slot configuration (left).

This isolation tool, although effective, is not too rugged and must be handled in the hole with care and caution. Further, it does not lend itself to the accurate spotting of acid since the acid can circulate only through the perforated nipple above the tool. However, by placing the tool initially below the perforations to be treated, acid can be effectively spotted across the formation, the tool raised into the isolation position, and the squeeze performed down the treating string with the annulus closed. The tool is most effective where only two sets of perforations are open. Three or more sets of perforations require pulling the tool to respace the packing elements. The uppermost set of perforations can be treated by running an insert pump anchor with rubber element just below the perforations, spotting acid, setting the tool, and then squeezing down the annulus.

The surface pack-off arrangement used in these treatments can be made up in various ways. The two most popular are a 5000-psi test stuffing box with rubbers to fit 1-in. tubing, or, for more convenient stripping of collars, tubing stripper may be used.

Commercial tool. Recently, a 2½-in. nominal straddle tool has been designed and built which remains selective regardless of the number of sets of perforations open and which eliminates the need for high-pressure surface pack-offs. The tool, Fig. 2 (right), allows the operator to treat any number of sets of perforations while moving up or down the hole as desired. An option of two slip arrangements is available. The tool can be furnished with a slip and J-slot arrangement (Fig. 2, left) or the operator can use an insert pump anchor with rubber and upper head removed for the lower slips (Fig. 2, center). The insert anchor hook-up eliminates the need to turn the pipe to set the slips because of the built-in reciprocating-set action of the anchor. Both of these units screw into the bottom of the treating tool.

In operation, the connection just below the perforated nipple of the tool is boken out and a sufficient length of 1¼-in. regular tubing is inserted between the rubber elements to span the longest set of perforations to be treated. When the tool is run to depth, acid is spotted down the 1-in. tubing and flows outward through the upper ports, the perforated nipple, and the lower ports. The tool is then set by engaging the slips (by appropriate optional method) and setting down weight which in sequence closes the lower ports, initiates the lower seal, then the upper seal, and finally closes the upper ports.

Through three sets of annular pistons, the tool shortens itself to pack-off in proportion to the treating pressure. This eliminates any unbalanced hydraulic forces, resulting in the 1-in. tubing being free from tension or compression loads.

This tool has held differential pressure of more than 5000 psi and has been unseated with a 4000-psi pressure differential to measure its ability to withstand equalizing forces. It has performed very well in test-well applications and field evaluation is under way. It is probably the first real "off-shelf" straddle tool designed specifically for selective treating in slim holes.

Cement Squeezing

Plugbacks and gas or water shut-offs can be accomplished easily in 2½-in. casing with a minimum of problems. Usually, plugs and water shut-offs are done by dump-bailer spotting of cement followed by a bradenhead

FIG. 3. **Commercial bit** is used for drilling a cement column in 2⅞-in. casing.

William D. Shannon *was graduated from the University of Missouri in 1956 with a bachelor of science degree in mechanical engineering. Upon his graduation, he joined Creole Petroleum Corporation in Western Venezuela and spent an 18-month training assignment in offshore drilling, completion, and production, and in general area engineering. He was then transferred to Creole's Planning Group in Maracaibo for reservoir engineering training. While there, he did some work on modifications of offshore flow stations for a gas gathering system.*

He is presently employed as the staff mechanical engineer for Stekoll Petroleum Corporation's Dallas-based operations. His responsibilities cover company-wide operations in Canada, Venezuela, Trinidad, and the United States.

squeeze. Gas or upper perforation shut-offs can be accomplished in a like manner when done on top of a drillable 2½-in. bridge plug run on wireline or on tubing. Plugs and shut-offs can also be done through open-ended 1-in. tubing followed by cement reverse-off back up the 1-in. tubing. A high-pressure 2½-in. by 1-in. pack-off and stripper is needed for these jobs.

Cement Drilling Tools

Stekoll uses two bits for cement clean-out. One, Fig. 3, is a commercial bit which is very satisfactory if circulation rates are maintained from 8 to 10 gal per min and penetration rates are kept low enough to insure cement chip removal. The other bit, Fig. 4, is shop made and is a very inexpensive and relatively fast-cutting bit which has proved most serviceable and popular in our operations. Maximum cost to fabricate this bit runs less than $10.

Cement Drilling Techniques

Two basic methods of drilling cement plugs are used with slight variations depending upon the area and the operator. Generally, the bit is run on 1-in., EUE tubing (N-80). If the length of the cement column to be drilled is 300 ft or less, power tongs are used to turn the pipe. With the commercial bit, circulation is down the 1-in. tubing and out the annulus, but reverse circulation is used with the shop made bit. This method yields a drilling rate of approximately 16 ft per hr.

If the cement column exceeds 300 ft, a rented drilling head is used. However, a special kelly is required to enter the 2½-in. casing. This kelly is fabricated from 1½ by 1½ by ¼-in.-wall square tubing. Upper and lower fittings as well as bushings are easily fabricated in a machine shop. The finished kelly length is 40 ft. Drilling rates with this hook-up are somewhat increased, but are limited by the circulation rates necessary to insure complete removal of cement cuttings.

Fishing Tools

As in any fishing job, shop made devices frequently show up on the lease. In the case of slim hole fishing, the appearance of shop made tools occurs no more frequently than in conventional fishing jobs. For example, the following items used for slim hole fishing are commercial items and are readily available: A 2¼-in. OD overshot socket with various sized internal slips; mouse trap-type sucker rod fishing tools used in the larger sizes to fish 1-in. tubing; and rope spears and jars to work inside of 2½-in. casing. Specialty items can be built for stubborn fish: Overshot barrels made from 2⅛-in. OD by 5/32-in.-wall seamless tubing; friction catches from the same material; overshot mills made by adding hard-face weld beads to the overshot barrel nose; end mills made from square-nosed bull plugs faced with hard-face weld beads; and clean-up mills made from swages with hard-face weld beads placed inside the bell.

Fishing is usually done by a pulling contractor under the supervision of a field engineer. As in any fishing job, a clever and determined field man can usually retrieve the fish or mill it up and push the remains to bottom and save the well. Stekoll has not yet lost a slim hole due to an unrecoverable fish.

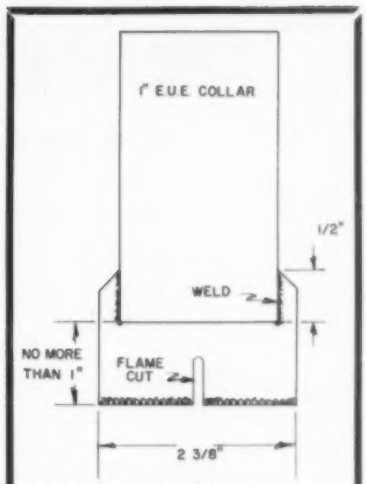


FIG. 4. **Shop made bit** used for cement cleanout can be fabricated for less than $10 from a piece of leaf spring welded to a 1-in. collar and a hard-face weld bead added to the resulting blade.

Conclusion

These are some of Stekoll's solutions to operating problems within the scope of shop made and presently available commercial completion and workover tools. Future articles are planned to discuss running casing, cementing practices, perforating, and well and casing head arrangements. Other proposed articles will deal with a most important topic — pumping practices and the reasons for pumping with hollow sucker rods. ★ ★ ★

Advanced Drilling Course Offered by Texas A & M, AAODC

THE PETROLEUM ENGINEERING DEPARTMENT of the A&M College of Texas has completed plans to offer an advanced drilling engineering course for petroleum industry personnel. The course is also sponsored by the American Association of Oilwell Drilling Contractors through a grant of $2500 to the department for the purpose of assisting in instituting the course.

Two identical sessions of the course will be conducted during the period of January 4-15, 1960, and April 25-May 6, 1960. The sessions will be held in the Memorial Student Center on the campus and will consist of both lectures and supervised computation, approximating eighty hours of instruction. The lecturers for the course will be selected specialists from industry and members of the petroleum faculty.

The course will stress drilling engineering fundamentals with particular emphasis directed toward drilling economics and contractor-operator relations. The course outline has been announced as follows:

I. Introduction — 2 hours
II. Rocks — 6 hours
III. Circulating fluids — 8 hours
IV. Drill strings — 8 hours
V. Rotary drilling bits — 7 hours
VI. Crooked hole problems — 4 hours
VII. Controlled directional drilling — 4 hours
VIII. Factors affecting rate of penetration — 4 hours
IX. Factors affecting hole oversize, sloughing, uniformity of wall, and differential sticking of drill pipe — 3 hours
X. Design and selection of various component parts of the drill string — 4 hours
XI. Optimum conditions for rock penetration — 4 hours
XII. Operations associated with drilling — 8 hours
XIII. Drilling economics — 14 hours
XIV. Methods of reducing drilling costs — 4 hours

Although the course is not to be offered for college credit, registrants should have the equivalent of an engineering degree plus a minimum of one year of experience in the drilling branch of the petroleum industry.

Registration fee is $250 per person, excluding room and board, and is payable in advance. Further information concerning the course may be obtained from Robert L. Whiting, Petroleum Engineering Department, A&M College of Texas, College Station, Texas.

'Desert Star No. 2'

Joins Libyan Drilling Fleet

Huge trailer-mounted rig will explore desert concessions for Camdrill International, Inc.

THE WORLD'S LARGEST trailer-mounted drilling rig has begun work in one of the world's most formidable drilling areas. Known as the Desert Star No. 2, the rig has been shipped by Camdrill International, Inc., to Libya, where it will take part in the rapidly expanding exploration of this North African country. The country is flat, covered with sand, and roads are non-existent, but the Desert Star No. 2 has been designed and constructed to be the most efficient rig operating under the prevailing adverse conditions.

The new rig is similar to the Desert Star No. 1 which was shipped by Camdrill (a subsidiary of Southern California Petroleum Corporation of Los Angeles) to Libya in December 1958. (See *The Petroleum Engineer*, January 1959, p. B-56.) Within 17 days after arrival in Libya, the Desert Star No. 1 was at work for Esso Standard (Libya), Inc. After completing two wells for Esso in Concession No. 1 near the Algerian border, the Desert Star No. 1 has recently been moved to Esso's Concession No. 6 near the Zelton discovery area where the first two wells drilled produce in excess of 15,000 bbl per day.

The huge Desert Star No. 2 is one of the most completely unitized mobile rigs of its size ever built. Its major components are mounted on five semi-trailers which will be pulled over the desert by diesel trucks equipped with high flotation-type sand tires. The trailers travel on 24 huge 21:00 by 25 in. sand tires. Camdrill officials say that the rig "has a capacity for drilling to depths of 10,000 ft and can be moved as far as 1200 to 1400 miles over the desert without roads."

Power Plant

Built to drill to 10,000 ft with 4½-in. drill pipe, the rig is powered with four 12-cylinder diesel engines and equipped with a new portable telescoping mast capable of handling drill pipe in trebles. Two of the 375-hp engines power the drawworks through a 2-engine, 3-shaft in-line compound. Another engine drives a 300-hp slush pump, and the assembly is mounted on a separate trailer. On another trailer, a 600-hp slush pump receives power both from an additional 375-hp engine and through a propeller-shaft drive from the drawworks compound. The diesel engines are equipped with 24-in. converters for smooth transmission of power.

All engines have oversize radiators, dual air cleaners, and dual fuel filters. Installation of special crude oil filters

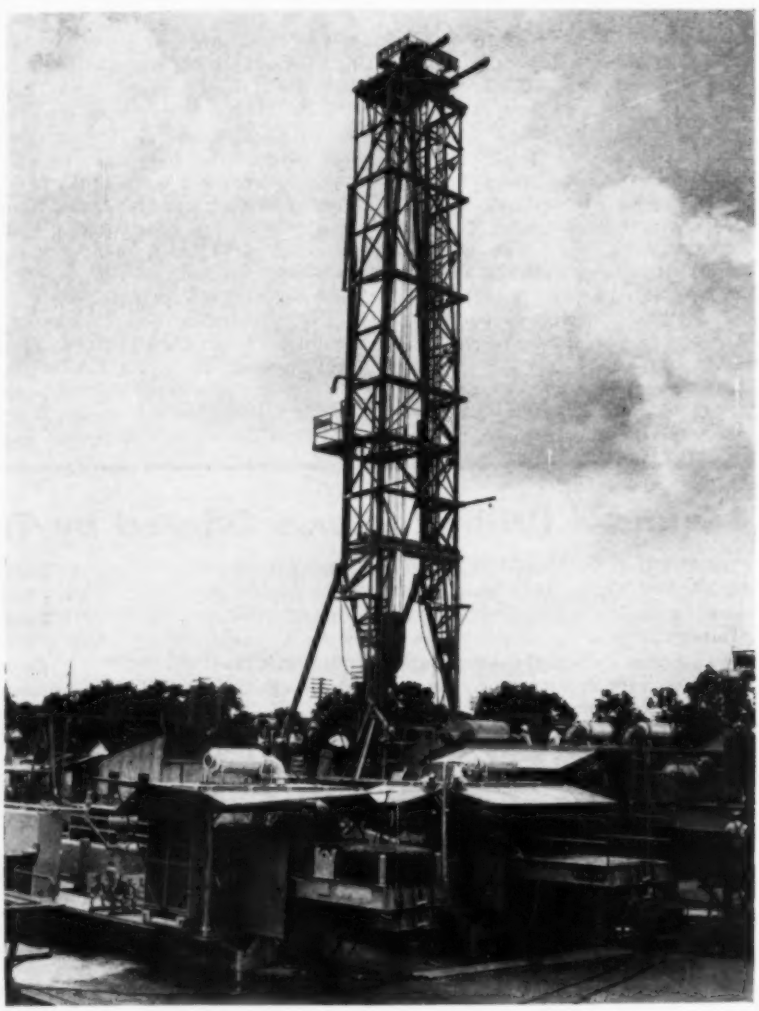


FIG. 1. **Major components** of Camdrill's Desert Star No. 2 are mounted on five semitrailers pulled over the desert by trucks equipped with high flotation-type sand tires. Rig-up and moving time is reduced to a minimum by complete wheel mounting and unitizing of pump manifolding and mud tanks. The mast extends to a height of 127 ft.

enable the units to burn low-grade diesel fuel or crude oil, whichever is available at this distant drilling site. In addition, light metal shade panels have been installed for protection from the intense heat and excessive dust. All chains are completely sealed and only one chain to the rotary needs to be disassembled to move the rig.

Since supplies are a major desert problem, Camdrill has equipped the rig with engine and machinery spare parts. A utility trailer carries a complete set of fishing tools and a mechanic's workshop. All except major repairs can be made on location.

Mobile Equipment

The rig's five semitrailers include the drawworks trailer, mast trailer, two heavy-duty pump trailers, and a heavy-duty utility trailer. The 127-ft trailer-mounted drilling mast has a hook-load capacity of 300,000 lb with an eight-line string up. A double-drum drilling and workover hoist is mounted on the drawworks trailer. The mud system, excepting the mud tanks, is completely wheel-mounted on two trailers equipped with tandem 30-ton bogie units. Storage bins are built into each side of the trailers over the bogie units.

The mud manifolding system is completely built into the pump trailers to reduce rig-up time and to increase the independence of the rig. The manifolding system is built to operate the pumps singly or in compound. A 500-bbl mud tank (12 ft wide by 40 ft long) has four compartments for mixing, settling, suction, and storage.

A complete mechanic's workshop is built into the utility trailer. Bins store fishing tools and subs, as well as engine and machinery spare parts. Two 65-kw electric sets are mounted on the trailer to provide power for auxiliary equipment and lighting. Power for the base drilling camp site is furnished by two 100-kw electric sets.

Present Contracts

Desert Star No. 2 has begun working for the Oasis Oil Company of Libya, a combination of The Ohio Oil Company, Amerada Petroleum Corporation, and Continental Oil Company. Camdrill has 10 contracts with five of the large American operating companies exploring and developing Libyan concessions. Camdrill's Libyan operation is under the direct management of Scott A. Murray, general manager for Camdrill in Libya and the Mediterranean region.

Many minor innovations and improvements have been made on the Desert Star No. 2, and it is anticipated that it will truly be the star of the Libyan desert drilling operations. ★ ★

FIG. 2. **Five semitrailers** which move the rig include the drawworks trailer, mast trailer, two heavy-duty pump trailers, and a heavy-duty utility trailer. Compartmented mud tank in foreground is skid-mounted.

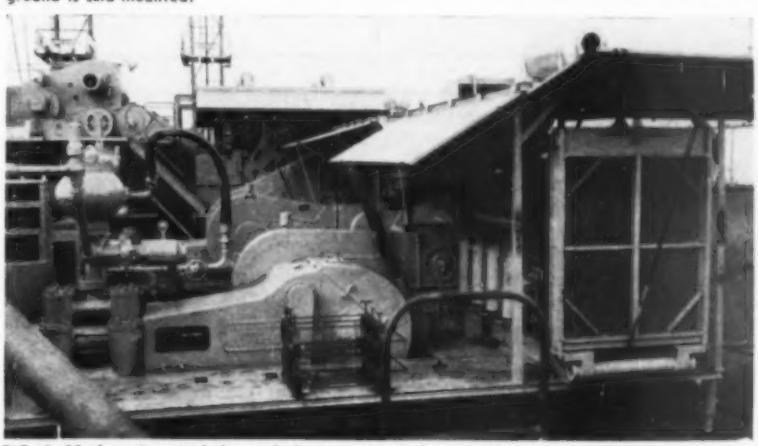


FIG. 3. **Mud system** includes a slush pump driven by a 375-hp diesel engine, both mounted on one trailer. Another trailer mounts pump which is driven by a 375-hp engine and through a propeller-shaft drive from the drawworks compound. Pumps are manifolded for operation singly or in compound.

FIG. 4. **Developers and operators** of the new Desert Star No. 2 are (left to right): E. L. Pierotti, Libyan superintendent, Camdrill; Gordon Wilbur, manager of foreign sales, Ideco; W. H. Mannon, vice president, Camdrill; G. W. Walton, president, Ideco; J. D. McBrayer, Ohio Oil Company, Findlay, Ohio; R. C. Kerr, consultant and engineer, Camdrill; R. M. Churchwell, manager of foreign operations, Ohio Oil Company; Tyler F. Woodward, president, Camdrill; Raymond O. Turner, executive vice president, Camdrill; Orville Stanford, supervisor, Camdrill.

NEW API FACILITY FOR . . .

Standardization and Calibration of Nuclear Logs

W. B. Belknap
Phillips Petroleum Company
Bartlesville, Oklahoma

The many variations in units and methods of recording nuclear log measurements may soon be eliminated by standardized log forms, defined radiation units, and calibrated testing pits created by API

LACK OF STANDARDIZATION and a need for calibration of radioactivity logs has resulted in a unique facility for logging and perforating companies. A standardized nuclear log calibration facility has been constructed on the campus of the University of Houston as a result of the work of the API National Subcommittee on Revision of *RP 33: Recommended Practice for Nuclear Logs.*

The committee was appointed in June 1956, by the Division of Production, American Petroleum Institute, to accumulate all available suggestions for revision of *RP 33* and to develop a standard practice that would create uniformity and allow direct comparison of radioactivity logs. At the time the subcommittee was formed, several independent studies had been made to develop conversion factors for comparing various logging companies' gamma ray logs. There was considerable variation in these conversion factors. Adequate calibration probably could have led to a system of conversion factors between the various units used for measuring radiation, but it would be too cumbersome and time-consuming to be practical.

Existing Conditions

Numerous logging and perforating companies run gamma ray and neutron logs using different units for measuring radiation, different procedures for checking and calibrating logging instruments, different log headings, and different log scales. The existing differences in log measurements make comparison of radiation measurements made with logs run by different companies virtually impossible.

In 1956 a survey of nine logging companies offering radioactivity logging showed a wide variety of gamma ray and neutron log units for measuring radiation. In the nine companies, seven different units were used for measuring gamma ray radiation, and there were six different neutron log units.

Several of the logging companies have made changes and improvements in their calibration of gamma ray and neutron logs since the foregoing survey was made. These improvements have not improved the feasibility for comparing the radiation units used by different companies. Essentially the same situation exists today as did three years ago. For example, three companies are using microroentgen per hour to measure gamma ray intensity. In checking the logs run by these companies against each other one finds that the units used actually vary by a factor greater than 2.

Revised Recommended Practice

The subcommittee appointed to review *RP 33* investigated the existing conditions of standardization of log headings, forms, units for measuring radiation, and calibration procedures and found that in order for radioactivity logs to be compared directly they must be recorded in the same units of measure. Leading to this objective the subcommittee accomplished the following:

1. Designed a standard log heading and form.
2. Established a standard API gamma ray unit of measure.
3. Established a standard API neutron unit of measure.
4. Designed and promoted construction of a calibration facility for nuclear logs.
5. Developed a standard procedure for presentation of calibration data.

These accomplishments resulted in the publication in September 1959, of a revised API *RP 33* containing recommended forms and details of procedures to be followed for calibration of nuclear logging tools in standard API units for measuring radiation.

Standardization of Log Form

One of the subcommittee's early actions was to change the name of logs classified as "radioactivity" logs to "nuclear" logs. This change was considered desirable because the term nuclear more accurately describes the various types of logging commonly referred to as radioactivity logging. The term nuclear was considered more general and inclusive of several types of experimental logging devices being developed

Adapted from a paper entitled "API Calibration and Standardization of Nuclear Logs" presented by the author at the Spring 1959 meeting of the Mid-Continent District, Division of Production, American Petroleum Institute, April 22-24, 1959, Amarillo, Texas. The author served as chairman of the Subcommittee on Review of API RP 33.

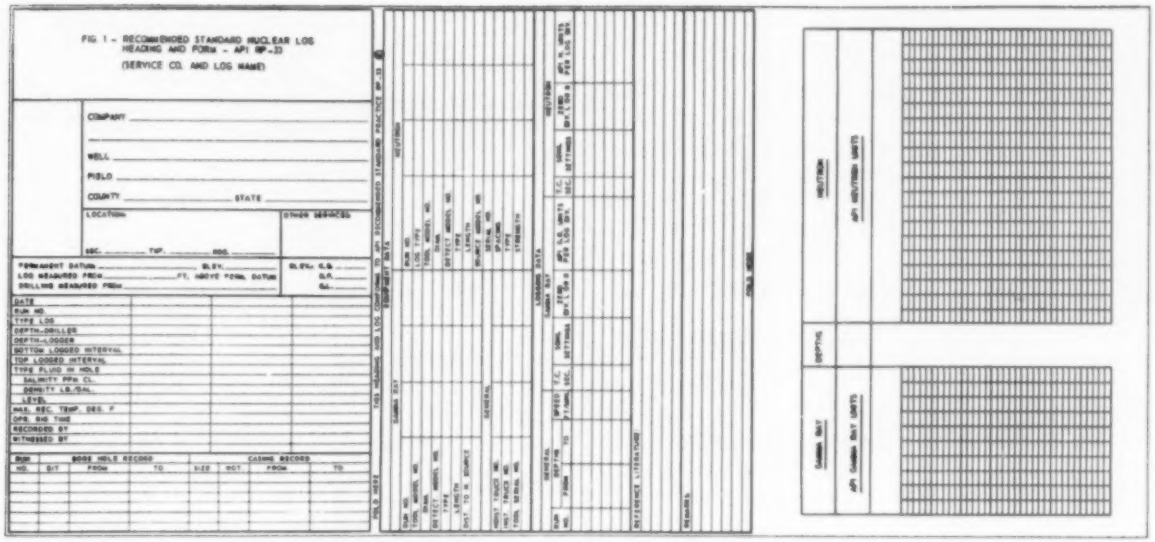


FIG. 1. **Recommended standard** nuclear log heading and form provides space on the heading for all data pertinent to the log and to the well. A standard practice is recommended for the size of the log, grid for recording the logs, and placement of basic logs, time signal, and collar logs.

using the principles of nuclear physics.

A standard format for nuclear log headings, including a separate second page for equipment and logging data, has been designed as a part of the revised *RP 33*. Fig. 1 shows this recommended standard heading and data page. Space is provided on the heading for all data pertinent to the log and to the well. In addition to the heading, a standard practice is recommended for the size and folding of logs, grid for recording the logs, and placement of basic logs, time signal, and collar logs. The recommended heading is 6 in. wide and 8½ to 9 in. high, and should be the front of the folded log. The upper half of the recommended standard heading is the same for both nuclear and electrical logs.

The revised *RP 33* includes recommendations for a standard form for calibration data. It recommends that the following data be recorded on every gamma ray and neutron log on the surface before and after logging:

1. Instrument zero before recording calibrated references.
2. Background counting rate before recording calibration references.
3. Calibrated references related to radiation level of API standard gamma ray pit and to log deflection for neutron pit.
4. Instrument zero after recording calibrated reference.

In addition to the calibration data, the revised *RP 33* recommends that at least a 150 ft repeat run be recorded; that preferably this repeat log should cover zones of interest near the bottom of well; and that a three-minute statistical check should be made recording both curves simultaneously while the logging tool is stopped opposite a zone of average radiation, using the same sensitivity and time constant settings as for logging the zone of interest.

Nuclear Log Calibration

The standardization of log headings, form, and presentation of field calibration data were desirable and necessary to fulfillment of the subcommittee's objectives, but the real problem was the establishment of standard gamma ray and neutron logging units for measuring radiation and the calibration of logging tools in these units. The subcommittee decided that the only satisfactory way for this to be done was to design and build a nuclear log calibration facility for the purpose of definition standard units for measuring log deflection and calibrating logging tools in these standard units.

The design of a calibration facility for the industry for this purpose was patterned after facilities constructed by several oil and logging companies for the purpose of research and development of interpretation methods for neutron logs. The University of Houston was selected as a site for the calibration facility. Placement at a university will provide an opportunity for additional use of the calibration facility for academic research and education. Cost of construction was slightly less than $48,000, contributed primarily by oil companies through the API. The logging companies have committed themselves to financial support of the operating cost for the calibration facility.

Operation of the calibration facility is under the direction of the Petroleum Engineering Department at the University of Houston. Time may be reserved at the calibration facility by both logging and oil companies for calibrating logging tools and for research work. During the first year of operation preference in reserving time will be given to logging companies calibrating logging tools in current use. When the existing nuclear logging tools have been calibrated, the facility will be available for experimental work as long as this work will in no way harm or change the calibration pits in regard to their utilization as a primary calibration standard. It is intended that the calibration facility will provide a permanent standard whereby new logging tools may be calibrated or existing logging tools recalibrated whenever desired.

Separate pits have been constructed at the calibration facility for gamma ray and neutron log calibration.

Gamma Ray Log Calibration

The standardization of gamma ray log units for measuring radiation does not present any particularly serious problems. All gamma ray logs can be calibrated at very low gamma ray radiation and at a level of radiation near or above the range of normal gamma ray radiation from geological formations. By defining the two levels of radiation, a standard calibration can be established for calibrating all gamma ray logs in the same radiation units. The subcommittee considered that the only practical permanent means for defining such a calibration would be to build a

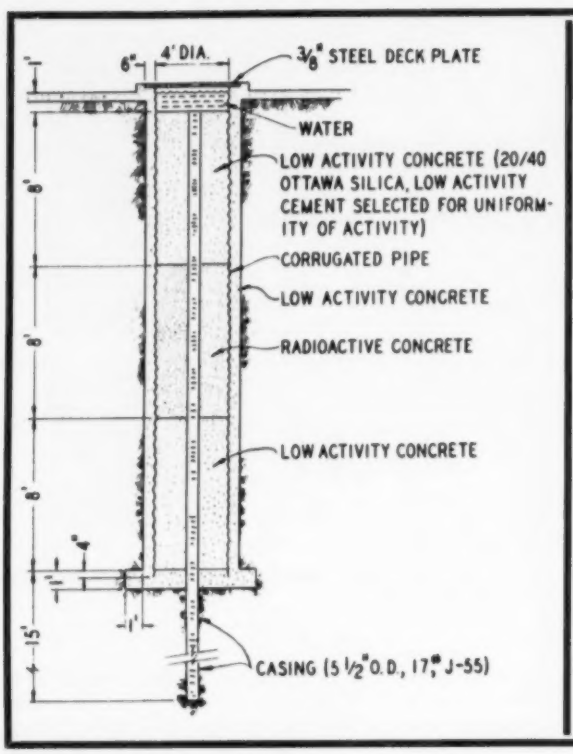


FIG. 2. **Gamma ray log calibration pit** comprises three zones of different radioactivity levels. Radiation is from uranimum, thorium, and potassium added to the concrete mixture. The standard API gamma ray unit is defined by setting the difference in log deflection for the two lower zones equal to 200 API gamma ray units.

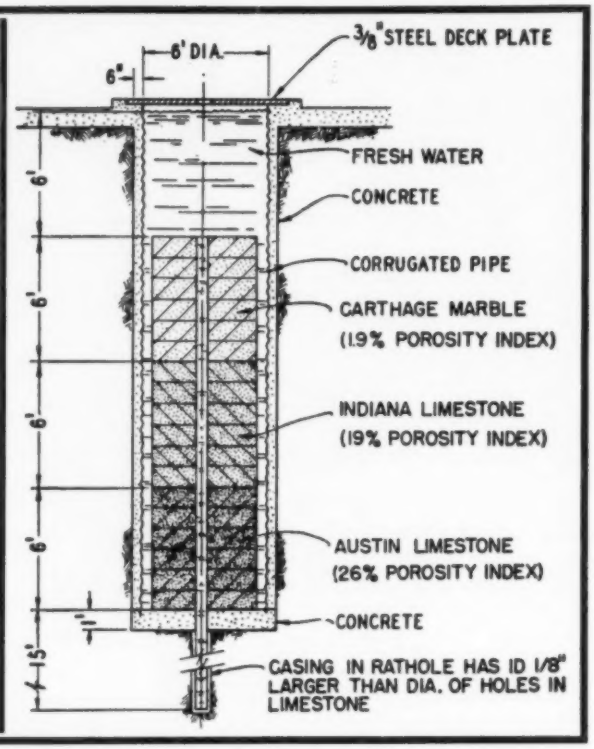


FIG. 3. **Neutron log calibration pit** contains three zones of limestone with porosity indices of 1.9 percent, 19 percent, and 26 percent. The standard API neutron unit is defined by setting the difference between instrument zero and log deflection opposite the center zone equal to 1000 API neutron units.

calibration pit with at least two zones with different levels of gamma ray radiation. This calibration pit could then be used to calibrate each type of gamma ray logging tool at these two levels of gamma ray radiation.

Fig. 2 shows the design of the gamma ray calibration pit. This pit is 4 ft in diameter and 25 ft deep. The 4-ft diameter hole is filled with three 8-ft thick zones of concrete. A 5½-in. diameter cased hole extends through the three concrete sections and 15 ft below the bottom of the pit.

The top and bottom zones are very low-activity concrete. The same source of cement and Ottawa sand was used to mix all three zones. The center zone contains a radioactive concrete equal to approximately twice that of an average shale. The gamma ray radiation level of the concrete in the center section was obtained by adding materials to the mixture resulting in a concrete zone containing approximately 12 ppm uranium, 24 ppm thorium, and 4 percent potassium. Completely stabilized radioactive materials were used for mixing with the cement, sand, and water for the concrete. The uranium and thorium presented no problem in this regard. A radium Ottawa silica sand mix was used as a source for uranium and monozite sand was used as a source for thorium. Mica was used as a stabilized source of potassium.

The center zone of the calibration pit was checked after reaching radioactive equilibrium with three different companies' logging tools and found to be two times the gamma ray radiation for the average shale. The average gamma ray radiation for Mid-Continent shales was used to design the pit for establishing the gamma ray calibration level.

The standard API gamma ray unit was defined by setting the difference in log deflection for the two lower zones in the gamma ray calibration pit equal to 200 API gamma ray units. This calibration results in a log deflection of 100 API gamma ray units for an average shale. All gamma ray logs calibrated to these standards will record gamma radiation in the same units of measure.

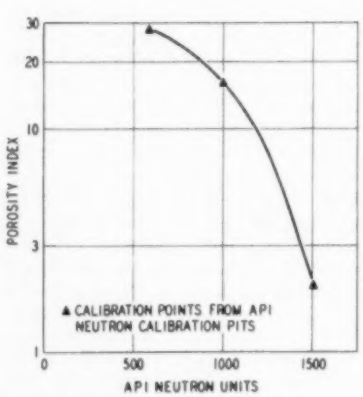
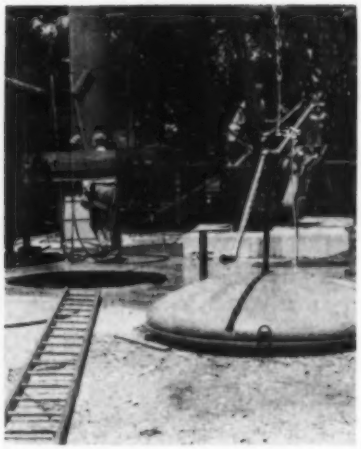


FIG. 4. **Typical neutron log response curve** permits uniformity in presentation of neutron log calibration data and in log-interpretation procedures.

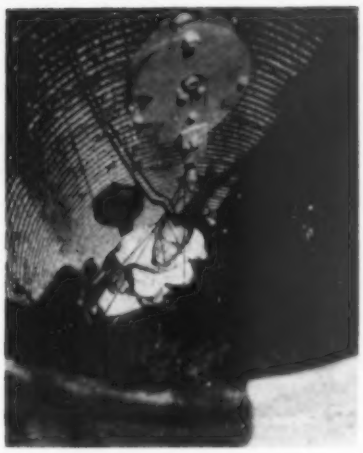
Neutron Log Calibration

Problems associated with standardizing units for measuring neutron log deflection are considerably more complex than for standardizing gamma ray units. There is no practical means for establishing artificial conditions representing the measurements made by various neutron logs. The subcommittee decided that the best method for standardizing neutron log measurements would be to calibrate neutron logging tools at instrument zero and one point of neutron log deflection. In order for this method of calibration to be meaningful, it is necessary to use the logging tool in the same manner in which it will be used to log a well, i.e., to use the same type of counter and

Limestone blocks used in gamma ray calibration pit were measured for bulk volume calculations . . .



. . . saturated with water in a special calibrated saturation chamber, and then lowered into the . . .



. . . calibration pit where they were aligned and arranged into three zones of different porosity.

neutron energy source in the tool with the same spacing and other design details. The committee agreed to use clean water-saturated limestone in a calibration pit free from external radiation to establish the second point of calibration for neutron logs.

Fig. 3 is a detailed diagram of the calibration pit for neutron logs. This calibration pit is 6 ft in diameter and 24 ft deep with three 6-ft thick limestone zones of varying porosity. The limestone blocks were saturated with fresh water and the pit will be kept full of water at all times. There is a 6-ft water shield above the limestone blocks. The limestone blocks are octagonal, 1 ft thick and 5 ft across with a 7⅞-in. hole in the center. The bottom zone of 6 limestone blocks was cut from Austin limestone of 26 percent porosity, the middle zone from Indiana limestone of 19 percent porosity, and the top zone from Carthage marble of 1.9 percent porosity. The product of porosity and water saturation is used as the porosity index for the various zones. Saturation in each section exceeded 97 percent.

Only the center limestone zone of 19 percent porosity index was used to establish the standard API neutron units and for calibrating logging tools in these units. It was considered desirable to include the additional zones of low porosity and high porosity in order that a response curve through the entire range of porosities usually encountered in geological formations could be established for each neutron logging tool. This provides valuable information concerning the calibration of each tool through the entire range of porosity. It will enable the various logging companies to tie in their response-curve data for varying hole sizes and fluids with the API calibration.

The API standard neutron unit is defined by setting the difference between instrument zero and log deflection for neutron counting rate opposite the center limestone zone equal to 1000 API neutron units. All neutron logging equipment calibrated by API standards will record logs that read in API neutron units. Because there is considerable difference in response of various neutron logging tools in different ranges of porosity, the two additional limestone zones provide the data for a response curve for each tool throughout the usual range of porosity. The API neutron units used for recording logs will provide good direct comparison of logs in most cases without reference to response curves. Hole-size change and variation in salinity of fluids in the hole greatly affect some types of neutron logs, and additional response curves will be required for detailed evaluation considering these variables. Neutron logs are affected to a certain extent by shale content, chemical composition, and other formation characteristics. This calibration system is based on clean limestones, and empirical adjustments must be made when formations deviate from this base.

Response Curves

In order to create uniformity in presentation of neutron log calibration data and in log-interpretation procedures, the subcommittee developed a standard practice for presenting neutron log response curves. Fig. 4 illustrates the recommended form for presenting response curves. Graph paper with a linear horizontal scale and an appropriate vertical scale is recommended. The API standard neutron units established by using the API neutron calibration pit should be used as the abscissa or linear horizontal axis for the response curve. The porosity index, should be plotted as the ordinate or vertical scale of the response curve. It is anticipated that a logarithmic scale normally will be used as the ordinate for the response curves. The neutron calibration pit provides three points to plot the response curve for the calibration pit conditions. In the revised *RP 33*, the response curves are described, and it is recommended that the three API calibration points and any curve drawn from them should be adequately marked in logging-company publications containing response curves. Additional response curves may be developed by the logging company for other size holes and fluids and placed on the same graph for convenience in correcting for these variables.

Conclusion

The active interest shown by logging companies through work on the subcommittee, commitment to financial support of operating costs for the calibration facility, use of the facility during the first three months operation, and reservations for future use indicate full support of this recommended practice. Needless to say, the oil companies and other users of nuclear logs have been most active in their support.

The revised *RP-33* was adopted by the industry without a dissenting vote. Users of nuclear logs are anxious for the API calibration and standardization to become generally used by logging companies. Use of nuclear logs which have been calibrated under and conform to the API standards will prove a tremendous forward step in developing better and more adequate formation evaluation from these logs. ★ ★

P 425.212.6

Brake-Block Requirements for Drilling and Servicing Rigs

Principles of operation analyzed to enable proper selection and care of braking mechanism for smooth, uniform feed-off and stopping action

F. W. Barton, Jr., *Reddaway Manufacturing Company, Inc., Newark, N. J.*

THE BRAKING MECHANISM of the modern-day drilling rig contributes materially to the efficiency with which wells are drilled and serviced. Since the brakes support the weight of the drilling string through the hoisting system, it is important that this part of the machine be maintained properly.

Basic qualities and constructional features which should be incorporated in the brake blocks to make the brakes perform as the builder intended them to are presented here.

Each of the three distinct types of machines used for the drilling and servicing of oil and gas wells — rotary drilling rigs, cable tool drilling rigs, and well servicing rigs — have particular brake requirements.

Water-Cooled Brakes

Rotary drilling rigs. Brakes employed on rotary drilling rigs are usually equipped with water-cooled brake rims. A constant flow of cooling water is circulated inside the rim so that frictional heat is dissipated by the cooling action of the water, thus preventing excessive brake-drum temperatures.

Brakes on the main drilling drum have several functions to perform. They must stop and hold the load of the drilling string when the elevating system raises it from or lowers it into the hole.

They must also permit the smooth and uniform slippage, or feed-off, of the drilling drum during the actual drilling operation. This is important in obtaining rapid penetration, keeping the hole straight, and in making perfect cores when samples of the strata are being taken.

Brake block characteristics. To accomplish these results, the brake bands must be equipped with brake blocks having certain desirable characteristics.

In order to produce the proper feed-off action, the static and dynamic frictions of the brake blocks should be equal or as nearly equal as possible.

This will assure a smooth, non-grabbing friction characteristic for controlled slippage during the drilling operation, which helps the operator maintain the proper weight on the bit, resulting in rapid penetration and straight hole.

A certain amount of resilience should be inherent in the brake block to yield responsive action. Thus, the driller will be able through his controls to feel the action of the brake blocks on the brake rim, thereby giving him assured control over the entire operation.

Resilience can be incorporated in a brake block by using a weave structure having interlocking plies of fabric, which gives a good wear factor but is spongy enough to provide the desired amount of resilience.

Compounding of the brake block must be accurately controlled also, to prevent an excess of binding material which would make the brake block hard and unresponsive. Careful control must be exercised during the curing of the brake-lining material to be certain that all volatile ingredients have been expelled and the resinous materials have been cured out completely.

An incomplete cure produces a soft brake block which may glaze and lose its friction from slippage of the incompletely cured binders. Excessive softness will allow the brake block to squash down on the brake rim, thereby providing extreme responsiveness but destroying the feeding-off characteristics.

Chattering and noise during the feed-off operation would indicate a brake block which is too soft.

Correct shape. It is very important that the brake band contact the brake rim completely and evenly around its whole periphery. Brake blocks should be sufficiently rigid and shaped to the correct diameter of the brake flange.

This helps to hold the brake band in shape so that it will retain the exact rim diameter for perfect all-around contact. In addition, this will make the band spring away uniformly from the rim when the brake is released so that there is no dragging, eliminating spotty contact with the brake rim.

Brake blocks which are given the final cure in jigs of exact diameter and are stored on edge and loose in containers to preserve this arc will assure the user these advantages.

Since a drilling rig is necessarily exposed to the elements, it is important that the brake-lining material be compounded properly to minimize the absorption of moisture and oil. Either or both of these contaminants will cause erratic performance and can occasionally be responsible for complete loss of brakes with dangerous consequences.

Operators should be very careful during drilling operations to protect the brake bands from becoming saturated with water or oil. If the operation is such that this possibility exists, it would be worthwhile to construct shields over the bands to give the desired degree of protection.

However, under no circumstances should the bands be totally enclosed so as to prevent the circulation of cooling air across the brake rims.

Friction. Brake blocks must necessarily be resistant to heat and therefore are usually constructed primarily of asbestos. This material is able to withstand up to 1400 deg F before complete degradation occurs.

Asbestos by nature is a mineral and is very abrasive. This abrasive characteristic is important since it yields a high coefficient of friction.

However, the compounding ingredients which are added to the asbestos base should be designed to temper the abrasive characteristics with lubricating

Adapted from paper number 59-PET-38 presented by the author at the Petroleum Mechanical Engineering Conference, Houston, Texas, September 20-23, 1959, held by the American Society of Mechanical Engineers.

qualities so that the proper balance is maintained between abrasion and lubrication. This will assure the maximum coefficient of friction consistent with the minimum amount of abrasion of the brake rim, which is perhaps the most important quality of a brake block from a cost standpoint. Undue scoring or galling of the brake rims necessitates frequent rim replacement, which is very expensive. In addition, the surface of the brake-lining material should be tough without being hard.

Surface toughness will prevent abraided metal from penetrating the brake block and turning it into a cutting tool. Most of the scoring which occurs is caused by brake blocks which have become loaded with metal picked up from the rim surface. This should be watched very closely to prevent frequent brake-flange replacement.

Air-Cooled Brakes

Cable tool and well servicing rigs. Generally used to drill wells less than 5000 ft in depth, cable tool rigs usually have a different braking system. They use the air-cooled type, with heat energy created during the braking operation dissipated by radiation into the atmosphere.

Well servicing rigs, like the cable tool rigs, generally are equipped with air-cooled brake flanges. They are used primarily for bailing, swabbing, cleaning, and restoring completed or producing wells to greatest productivity. This type rig also has attachments for rotary drilling.

Construction. Since the only means of cooling the brake rims is by radiation and by convection due to air forced across the under side of the flange surface, the brake blocks must be constructed so that they will withstand the high temperatures encountered.

It is not uncommon to have brake-flange temperatures reach 600 deg F and higher when the brakes are in constant operation, such as when tubing is being replaced in a well or, in the cable tool rig, when a trip is being made to change tools.

On some machines, the main hoisting drums are constructed so that they are freewheeling when the tools are being lowered into the hole. This means that the acceleration of the string of tools is quite high and extreme demands are placed on the brakes during the brake application.

It has been found for air-cooled application of this type that a metallic construction is desirable in the brake block.

Asbestos yarns containing tiny brass wire insertions (the wires being approximately 0.008 diameter) are used in weaving the brake blocks. In the most desirable construction these brass wires will run the entire width, length, and thickness of the fabric, thereby providing additional means of heat dissipation.

It is important that the brake block have intimate contact with the brake band so that heat may be conducted through the brake block and out through the band, thereby minimizing the build up of heat in the brake flange itself.

The brass wire construction allows the brake block to conduct heat in this manner. Every Btu of heat which can be prevented from entering the brake flange will help to minimize heat-checking, cracking, and scoring of the brake-rim surface.

The use of inert fillers applied between the brake blocks and the band during installation eliminates trapped air between the band and the blocks, thereby producing a good thermal bond for maximum heat transfer.

The brake bands themselves should always be thoroughly cleaned and free from rust and corrosion during the relining process. Under no circumstances should the brake blocks be painted in any manner, since the paint film would be an excellent heat insulator.

Resisting oil and water. On well servicing application, the brake blocks must be capable of withstanding the effects of oil and water. During bailing and swabbing operations, they are in danger of becoming soaked with these foreign substances, which could cause erratic operation and possible complete loss of friction. Here again, the brake blocks should be compounded properly to absorb the minimum amount of foreign substances.

The brass construction used in brake blocks for air-cooled operation helps to stabilize the coefficient of friction at elevated temperatures. This is important in preventing fade, which means partial or complete loss of friction at high temperatures. There is a common misconception that brass in a brake block will produce scoring of the brake-rim surfaces.

It has been proved through years of testing and field application in all sorts of automotive and industrial braking operations that this is not true. If the brake block is lubricated properly so that the abrasive factor is controlled, little or no scoring will be evident regardless of the type of brake flange which is being used.

Equalizing brakes. Brake equalization must be carefully watched at all times. Every drilling and servicing rig has some sort of brake-equalizing mechanism connecting the bands at either end of the drilling drum. When the brakes have been relined and the adjustments set, it is a good idea to use a surface pyrometer to check the temperature development in each brake flange to see that both bands are doing an equal amount of work.

Uniform brake adjustment yields even wear of both bands and prevents excessive temperature development in any one band.

The external contracting-type brake bands which are commonly in use on most rigs being built today frequently develop pressure spots around the periphery of the band. These generally occur at the anchored end of the band and about one third of the way around the band from the anchored position.

Considerable attention is being given to the use of molded brake blocks applied at these spots to prevent excessive wear and to polish the brake-flange surfaces by removing organic films. In many instances, this will give improved brake efficiency and minimize heat generation at the pressure spots.

A molded brake block is very dense and has little resilience. Care should be used in limiting the percentage of this type material on each band so that overall brake efficiency is not impaired.

Brake-Block Attachment

The conventional method of attaching brake blocks to the brake bands is through the use of machine screws or rivets. The blocks are drilled at the factory with the proper pattern of holes to match the drilled bands.

The holes in the brake lining represent a considerable amount of lost braking area. They also may induce ridging of the brake-rim surface along the line of holes around the diameter of the rim due to the lesser density at this point.

It has therefore become common practice to use plugs made of brake lining material to fill the holes, thereby presenting a smooth, unbroken braking surface which will eliminate ridges.

In some sandy or dusty locations, the unplugged holes in the brake blocks can become filled with these foreign substances, causing undue wear of the brake rims. The user should check to see that the plugs are a good, tight drive fit to prevent loosening during service.

Brake flanges which are badly ridged should be turned to a smooth face, otherwise very poor brake-lining contact will result when new blocks are installed.

Most present-day brake linings have been designed to give the user maximum life and performance when installed and operated according to the manufacturer's instructions. A little care used in following these directions will yield safe and economical operation. ★ ★ ★

Development and field tests of . . .

Hydraulic-Powered Drilling Sub for Light Rigs

This small hydraulic unit permits flexibility and ease of control in drilling operations with light well servicing and workover rigs

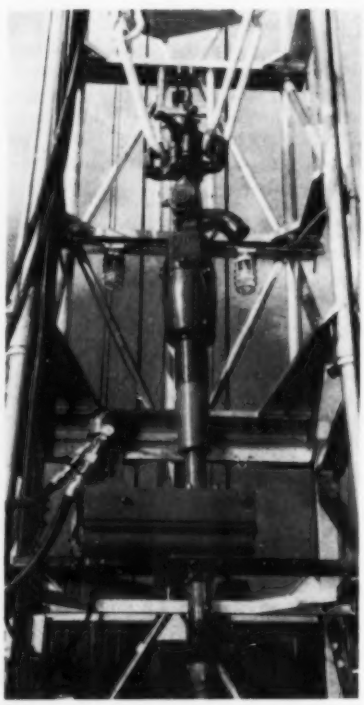
W. S. Jacobsen, *Fred E. Cooper, Inc., Tulsa, Oklahoma*

WITH THE WIDE USE of hydraulic power on well servicing and workover rigs, it was inevitable that hydraulic power would be adapted for rotating the drilling or tubing strings. Application of hydraulic power for rotary work has long been discussed and considered by contractors, oil producers, and manufacturers and it was only a matter of time before these tools would be available. Whether or not they are to prove practical or economical to the contractor will be proved through more extensive field use and application.

It is well known that for the past few years contractors have been using hydraulic-powered tubing tongs as a substitute power source for rotary operations on well workovers. This practice, while not prohibited by tong manufacturers, has not been wholeheartedly endorsed and many contractors have found that it has been an expensive operation for them. In practically all areas the practice of using tongs for rotary work has been on a gratis basis to the oil operators, thus the contractor has added one more nonchargeable expense to his operations.

Hydraulic-Powered Rotation

In the past one or two years three different approaches have been made by manufacturers in applying hydraulic power to rotate the drilling string. One manufacturer has on the market a hydraulic-powered rotary table. Another has designed and field-proved a hydraulic-powered swivel; that is, their own conventional swivel has been adapted for power from a hydraulic motor. The third manufacturer has approached the problem with a hydraulic-powered rotating sub that is used in conjunction with a conventional rotary swivel. This report deals with the field results of the third type mentioned above — the hydraulic-powered "Hydrasub" used along with the conventional rotary swivel. No comparison is attempted or intended against any other types mentioned as all mentioned above certainly have their own exponents and particular type of operations to which they may be better suited.



Hydraulic-powered drilling sub is used with a conventional swivel. The sub can be driven from the rig's hydraulic system or from a separate power unit.

When the decision had been made by the manufacturer to enter this market, considerable thought was given to which type of hydraulic-powered rotating tool would be built and offered to the buyers. After field surveys with contractors and users, it was decided that a hydraulic-powered sub to be used with a rotary swivel would be the best type to offer to the well servicing industry. One factor considered was that many contractors already operated and owned conventional rotary swivels and it would be more economical for them to use a hydraulic-powered device along with their present equipment rather than to purchase additional equipment.

The hydraulic drilling sub is manufactured in two sizes. Smallest size is rated at 30 hp with approximately 80 rpm at 2000 psi hydraulic pressure with 1330 ft-lb of torque. Larger size is rated at 60 hp with approximately 90 rpm at 2000 psi hydraulic pressure and 2150 ft-lb of torque. The smallest model can be operated, in most cases, from the derrick hydraulic system or the hydraulic power source of tubing tongs. However, the larger unit requires considerable more horsepower than normally found in either of the above mentioned power sources and the manufacturer recommends that a separate hydraulic source be used with the larger model.

Hydraulic Sub Features

One of the outstanding features of any hydraulic-powered sub or swivel is the elimination of the kelly from the drilling string, thereby reducing wear on the producing string or any production liner that may be in the hole. By using tubing without a kelly in a workover operation, it will allow free mud and cutting circulation, especially in the numerous slim hole completions now used so extensively.

Fishing operations are easier to control with the powered sub than with a rotary table and kelly. Accurate torque control on the tubing or drilling

string is of considerable help in any fishing work and by regulating hydraulic pressures this desired torque or control is easily obtained with any hydraulic sub or swivel.

One outstanding feature of this tool is that the operator is able to rotate the tubing or drill pipe the full height of the derrick. This is especially helpful when cave-ins or tight areas are in the well.

Field Results

Early in 1959, the first sub of this type was placed in service with a contractor in South Texas. The contractor has used the tool on all types of workover operations and at various depths. These jobs have varied from washdown operations, drilling of cement, cast iron, and magnesium plugs, and in various fishing operations. In all operations, the sub has performed far better than expected.

One workover operation included milling out a cast-iron plug on a 6700-ft well and the operator advised that tubing control and rotary control was better than had ever been experienced with normal rotary operations. The sub operated at 80 to 90 rpm with hydraulic pressures of approximately 1100 psi and six to eight points being carried on the milling tool. On one washdown operation, a 9⅞-in. hole was washed down from surface to 7000 ft using heavy mud with sub operating at 80 rpm and 800 psi hydraulic pressures.

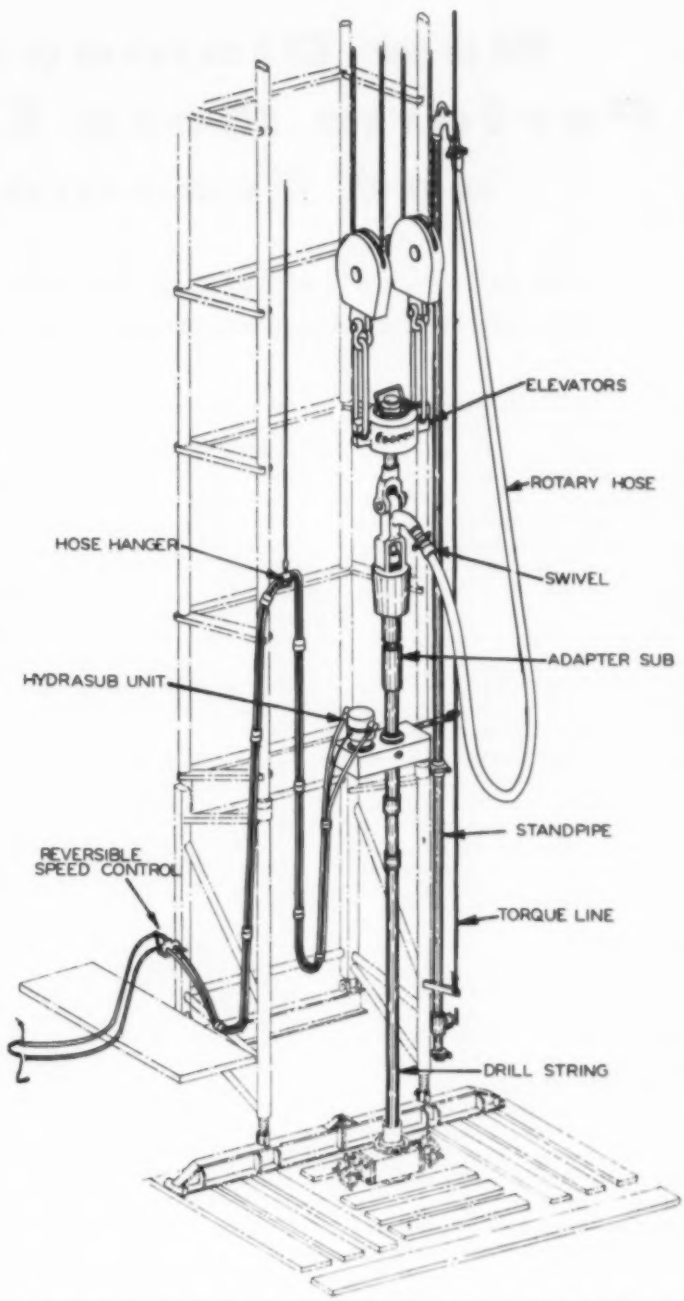
In all operations where the sub has been used by this contractor, he reports complete satisfaction by his customers. One oil operator pointed out to the contractor that in using hydraulic power on the tubing string, it has eliminated tubing jerking during rotary operation and there has been no thread burning or galling on the tubing couplings.

In May of 1959 a second sub of this design was used by a contractor in Oklahoma on a top-to-bottom new hole drilling job. At the beginning of this drilling job it was discovered that the sub was underpowered in relation to the hydraulic motor, and the stiff arm used to keep the sub from rotating was too light. These problems were corrected and the contractor was able to complete his drilling operations as contracted. On this drilling operation the hole diameter was 6⅝ in., rotation speeds varied from 22 to 88 rpm with hydraulic pressures of 500 to 1200 psi. Full rotary drilling operation was encountered by the contractor from digging the rat hole to complete well completion.

Another successful field test was in working over a gas well in West Virginia. On this particular job the contractor worked the well over without any fluid in the hole.

Recently, additional subs have been placed in operation in Oklahoma, Louisiana, and other Texas areas, adding further proof of the practicability of the hydraulic-powered sub on well servicing and workover rigs.

Customer acceptance of the "Hydrasub" has been one of the big factors in contractors purchasing the tool which is the final proof of any piece of equipment. ★ ★ ★



Typical hook-up of hydraulic sub is applicable on all types of standard pole masts and derricks.

New Diamond Tools Perform More Efficiently and Economically

High performance diamond tools and techniques developed recently offer new and important economies in coring and drilling operations

THE USE OF DIAMONDS in drilling and coring earth formations is generally conceded to have been introduced by Rudolph Leschot in Europe in the year 1862. It was only shortly thereafter that diamond drills were also used in America. For the next 70 years diamonds were used in bits and core heads at various times but without notable commercial success. However, in 1945, modern diamond coring essentially as we know it today was begun in the West Edmond field, Oklahoma.

Following this successful coring operation, many wells were then cored in the Webber sand of the Rangely field in Colorado. From this time on, successful diamond coring is a matter of record. Unless unusual conditions are encountered, this method of coring consistently recovers close to 100 percent of the formation cored.

Plan Ahead

The techniques used in today's successful coring operations have been well established. And today's prudent operators will make careful plans for each well to be cored long before coring operations begin.

After the last string of casing is run above the initial coring depth, special care is taken to keep the open hole clean of any junk iron, or similarly hard material.

Drillpipe wipers are used going into the hole as well as coming out, and junk baskets are run with the last several bits to assure a clean hole. A highly efficient junk recovery tool will also be run just prior to running the first diamond bit to recover any remaining junk, especially small pieces. An adequate number of drill collars should be used to keep the drill pipe in tension and if initial coring operations start in a rat hole, the drill collars used in the larger hole will be used until the entire length of the core barrel has entered the rat hole and it is then necessary to reduce the OD of the drill collars for clearance purposes; unless the hole is reamed after each core. The core barrel will be efficiently stabilized and the stabilizers will be replaced as soon as they are worn down to their minimum acceptable OD.

Hole conditions during coring operations, as well as the drilling equipment to be used, are carefully studied before the diamond core head or bit is selected for any particular diamond coring or drilling operation. If the operator is seeking maximum benefit in diamond coring or drilling operations, he may have the diamond core head or bit specifically designed for a particular set of coring or drilling conditions.

During diamond coring or drilling operations, very close attention will be paid to the operating conditions. After initial diamond coring or drilling operations have progressed a few feet, the bit weight, rotary speed, pump volume and pressure will be carefully recorded and studied. If operating conditions are satisfactory at this time, a normal or stabilized pump pressure will be established and any significant or unusual variation of this normal pressure there-

TABLE 1. Bit Performance Record Saint Mary Parish, Louisiana.

Bit No.	Type	Depth-Ft From	Depth-Ft To	Ft Drilled	Rotating Hours	Operating Hours*	Ft Per Rotating Hour	Ft Per Operating Hour	Net Bit Cost
56	Rock bit	13,643	13,649	6	8.5	16.5	.705	.364	$ 176.80
57	Diamond bit	13,649	13,893	243	175.0	190.0	1.390	1.280	1886.54
58	Rock bit	13,893	13,947	55	20.0	28.0	2.780	1.965	176.80
62	Rock bit	14,071	14,100	29	16.0	24.0	1.810	1.210	176.80
63	Diamond bit	14,100	14,456	365	161.5	175.5	2.220	2.090	1949.69
64	Rock bit	14,456	14,479	23	13.5	21.5	1.710	1.090	176.80
65	Rock bit	14,479	14,484	5	8.0	16.0	.625	.312	176.80
66	Diamond bit	14,484	14,597	113	74.0	86.0	1.530	1.321	2519.80
67	Rock bit	14,597	14,598	1	11.0	17.0	.095	.059	176.80
66	Diamond bit	14,598	14,676	78	57.0	67.0	1.380	1.160	Rerun
68	Diamond bit	14,676	14,695	19	33.0	41.0	.575	.463	1391.89
69	Rock bit	14,695	14,696	1	11.5	19.5	.087	.051	176.80
75	Rock bit	14,779	14,800	21	15.0	23.0	1.390	.980	176.80
71	Diamond bit	14,800	14,862	62	57.0	67.0	1.100	.925	1817.84
76	Rock bit	14,862	14,882	20	17.0	25.0	1.180	.800	176.80
77	Rock bit	14,882	14,904	22	16.0	24.0	1.370	.916	176.80
78	Diamond bit	14,904	14,939	35	29.0	37.0	1.200	.942	1174.36
79	Rock bit	14,939	14,943	4	14.0	22.0	.286	.183	176.80
80	Rock bit	14,943	14,945	2	11.0	19.0	.182	.105	176.80
81	Diamond bit	14,945	15,058	113	56.0	66.0	2.030	1.720	1574.36
82	Rock bit	15,058	15,088	30	14.0	22.0	2.140	1.750	176.80
89	Rock bit	15,296	15,297	1	5.0	13.0	.200	.077	176.80
90	Diamond bit	15,297	15,345	48	55.0	65.0	.890	.740	1739.83
91	Rock bit	15,345	15,348	3	14.0	22.0	.210	.136	176.80
92	Diamond bit	15,348	15,392	44	61.0	74.0	.720	.594	1875.20
93	Diamond bit	15,392	15,653	261	127.0	139.0	2.060	1.870	1611.26
94	Rock bit	15,653	15,675	22	13.0	21.0	1.700	1.050	176.80
95	Diamond bit	15,675	16,074	399	189.0	205.0	2.100	1.950	1875.65
96	Rock bit	16,074	16,100	26	10.0	18.0	2.600	1.440	176.80
17	Conventional rock bits			271	217.5	353.5	1.210	766	3005.60
11	Diamond bits			1771	1074.5	1212.5	1.65	1.460	19416.42

Average diamond bit cost = $10.96 per ft
Average rock bit cost = $11.09 per ft

*Operating Hours = Rotating hours plus 8 trip hours for each rock bit.
= Rotating hours plus 8 trip hours plus 1 hour "short trip" time for each 24 hour period the diamond bit was in use.

after will be occasion for immediate investigation to determine what is causing it to change.

The Diamond Drilling Bit

In analyzing diamond coring operations, it was discovered that extremely hard formations were cored at a much faster penetration rate than the best rock bits could drill. It was also apparent that a diamond core head would drill many feet of hard formation unless there was some unusual damage occurring. Various techniques were then developed in an effort to use the diamond core head for the primary purpose of reducing the time and cost of drilling hard formations.

The early diamond drilling bits did not prove satisfactory, so drilling and service companies interested in this problem began extensive research programs to develop a diamond bit that would efficiently drill hard formations. Diamond bits have been on the market several years which, in selective use, have effected savings as high as 50 percent over the use of rock bits for drilling extremely hard formations. As a general rule, bit costs and penetration rates are about the same (including both soft and hard formations) but significant savings result from the greatly reduced number of round trips due to longer operating time on bottom.

Recently, a major company has effected significant savings with the use of specially designed diamond bits in the place of rock bits in the drilling of selected portions of an interval from 13,055 to 16,100 ft in Saint Mary's Parish, Louisiana. In order to make a comparison between the drilling efficiency and costs of diamond and rock bits, it was necessary to establish some standards to determine the "drillability" of a formation. These were total bit footage and penetration rate when using rock bits.

Table 1 compares the performance of diamond and rock bits drilling a total of 2042 ft of Miocene formation at selected intervals in the depth range from 13,643 to 16,100 ft. Rock and diamond bits were alternated through four intervals, with rock bits drilling 271 ft and diamond bits drilling 1771 ft. In this comparison, only the rock bits used immediately before and after the diamond bit were included in this analysis. Summary figures show that conventional rock bits averaged 16 ft per bit against 148 ft for diamond bits. Average bit costs were very close, being $11.09 per bit for rock bits and $10.96 per bit for diamond bits. There is a marked difference, however, in the average penetration rate. The 17 rock bits used drilled 271 ft in 354 hours for an average of 0.71 ft of penetration per operating hour. In comparison, the 11 diamond bits drilled 1771 ft in 1215 operating hours, or an average of 1.46 ft per operating hr. Use of diamond bits effected a rig time saving of over 90 percent.

TABLE 2. Bit Performance Record Saint Mary's Parish, Louisiana.

Bit No.	Bit Size	Type	Depth-ft From	Depth-ft To	Ft Drilled	Rotating Hours	Operating Hours*	Ft Per Rotating Hour	Ft Per Operating Hour	Net Bit Cost
40	8½	Rock bit	13,055	13,093	38	19	27	2.000	1.410	$ 176.80
41	8½	Rock bit	13,093	13,166	73	30	38	2.410	1.910	176.80
42	8½	Rock bit	13,166	13,193	27	11	19	2.330	1.420	176.80
43	8½	Rock bit	13,193	13,214	21	14	22	1.830	.950	176.80
44	8½	Rock bit	13,214	13,231	17	12	20	1.410	.850	176.80
45	8½	Rock bit	13,231	13,251	20	12	20	1.660	1.000	176.80
46	8½	Rock bit	13,251	13,292	41	23	31	1.780	1.320	176.80
47	8½	Rock bit	13,292	13,332	40	17	25	2.360	1.600	176.80
48	8½	Rock bit	13,332	13,373	41	17	25	2.400	1.640	176.80
49	8½	Rock bit	13,373	13,421	48	18	26	2.680	1.840	176.80
50	8½	Rock bit	13,421	13,474	53	17	25	3.120	2.120	176.80
51	8½	Rock bit	13,474	13,502	28	13	21	2.150	1.330	176.80
52	8½	Rock bit	13,502	13,532	30	17	25	1.760	1.200	176.80
53	8½	Rock bit	13,532	13,573	41	17	25	2.350	1.600	176.80
54	8½	Rock bit	13,573	13,625	52	17	25	3.02	2.08	176.80
55	8½	Rock bit	13,625	13,643	18	13.5	21.5	1.340	.840	176.80
56	8½	Rock bit	13,643	13,649	6	8.5	16.5	.700	.360	176.80
57	8 7/16	Diamond bit	13,649	13,893	243	175.0	190.0	1.380	1.280	1886.54
58	8½	Rock bit	13,893	13,947	55	20.0	28.0	2.840	1.960	176.80
59	8½	Rock bit	13,947	14,000	53	20.0	28.0	2.620	1.880	176.80
60	8½	Rock bit	14,000	14,046	46	16.5	24.5	2.800	1.880	176.80
61	8½	Rock bit	14,046	14,071	25	16.0	24.0	1.500	1.050	176.80
62	8½	Rock bit	14,071	14,100	29	16.0	24.0	1.810	1.200	176.80
63	8 7/16	Diamond bit	14,100	14,456	356	161.5	195.0	2.220	2.040	1949.69
64	8½	Rock bit	14,456	14,479	23	13.5	21.5	1.720	1.070	176.80
83	8½	Rock bit	15,088	15,119	31	16.0	24.0	1.900	1.290	176.80
84	8½	Rock bit	15,119	15,165	46	16.0	24.0	2.880	1.920	176.80
85	8½	Rock bit	15,165	15,206	41	16.0	24.0	2.560	1.710	176.80
86	8½	Rock bit	15,206	15,239	33	16.0	24.0	2.060	1.380	176.80
87	8½	Rock bit	15,239	15,275	36	16.0	24.0	2.240	1.500	176.80
88	8½	Rock bit	15,275	15,296	21	15	23	1.400	.910	176.80
93	8 7/16	Diamond bit	15,392	15,653	261	127.0	139.0	2.060	1.880	1611.26
94	8½	Rock bit	15,653	15,675	22	13.0	21.0	1.700	1.050	176.80
95	8 7/16	Diamond bit	15,675	16,074	399	189.0	205.0	2.100	1.950	1875.65 Est.
96	8½	Rock bit	16,074	16,100	26	10.0	18.0	2.600	1.440	176.80
		31 Rock bits			1081	496	744	2.179	1.453	$5480.80
		4 Diamond bits			1259	652.5	729	1.931	1.727	$7323.14
		Rock bit cost per ft = $5.07								
		Diamond bit cost per ft = $5.80								

*Operating hours for rock bits = Rotating hours plus 8 hours for trip.
Operating hours for diamond bits = Rotating hours plus 8 trip hours plus 1 hour "Short Trip" time for each 24 hour period the diamond bit was in use.

"Operating hours" were standardized to include all rotating hours plus 8 hours trip time for each rock bit used. And for diamond bits, "operating hours" includes all rotating hours, plus the same 8 hours for trip time and an additional 1 hour of "short trip" time for every 24 hour period diamond bits were run.

A comparison was also made between rock bits and diamond bits in the same well drilling in medium-hard formation to determine possible economies. These data are tabulated in Table 2 and show that 31 conventional rock bits drilled 1081 ft in 744 operating hours for an average penetration rate of 1.45 ft per operating hour. Footage per bit averaged 34.9 ft. In comparison, 4 diamond bits drilled 1259 ft in 729 operating hours for an average of 1.73 ft per operating hour and bit footage averaged 314.5 ft. Costs averaged $5.07 per ft for 31 rock bits and $5.80 per ft for the 4 diamond bits. Although diamond bits cost an average of $0.73 per ft more, had they been used throughout the interval, a possible savings in rig time of approximately 19 percent could have been realized.

To establish a dollar value saving from the use of diamond bits, a total rig cost of $100 per operating hour was assumed. On this basis, it cost an average of $141.63 for every ft of formation drilled using rock bits in the interval covered in Table 1. In comparison, for this same interval it cost $79.44 per ft for diamond bits. On this basis, the savings from the use of diamond bits in place of rock bits for this 1771 ft interval are $110,138.49. Analyzing the savings effected from the use of diamond bits in drilling the softer formations, as indicated in Table 2, there is strong evidence to indicate that additional savings could have been made had diamond bits been used throughout the entire interval.

It should be emphasized that these savings were possible only after careful planning and consideration of every

well condition and piece of equipment being used in this operation. Without this careful planning, these significant savings could have been easily lost or seriously reduced.

Full-Hole Coring

It is significant to observe that when conditions permit, many economically-minded operators are now full-hole (full-diameter) coring. This allows the operator to obtain large-diameter cores and simultaneously effect substantial savings by eliminating costly reaming operations.

In the early days of coring, many companies were aware of the economy and general desirability of full-hole coring, however, this method was not practical because of poorly designed core heads and barrels and the lack of today's successful operating techniques. These imperfections were responsible for slow penetration rates, excessive hole caving and serious wedging of the core. Within the past several years these problems have all been sufficiently solved to the point where full-hole coring has become standard practice with many operators.

It was the application of a greater knowledge of efficient hydraulics in the rotary system of drilling that made it necessary to redesign the down hole coring equipment to provide a balance of all factors affecting down hole operations. This made possible much improved rates of penetration.

In one recent full hole coring operation in the Yantis field in Wood County, Texas, two 8⅝ by 3½-in. coreheads cut 17 cores from 9417 to 10,705 ft for a 100-percent recovery of 1288 ft. The bits were on bottom for a total of 97.5 hours achieving an average penetration rate of 13.2 ft per hour. In another example of full-hole coring, a treacherous formation in South Louisiana was cored from 13,540 to 13,657 ft, recovering 3 cores totalling 117 ft, or 100 percent of the core cut. The bit was on bottom for 39.5 hours achieving a penetration rate of 2.97 ft per hour. This same 9⅞ by 4⅞-in. core head cut another core from 13,799 to 13,851 ft recovering 100 percent, or 52 ft of core. The time on bottom was 11.5 hours for a penetration rate of 4.5 ft per hour.

In another interesting coring operation in Plaquemine Parish, Louisiana, the operator was drilling with rock bits below 15,000 ft, and the last bit before coring operations began made 11 ft in 14 hours but no footage in the last 3 hours. This formation was normally side-wall cored because of its depth and operational hazards in this area. So there was considerable doubt concerning the success of this coring operation. However, the first core run from 15,159 to 15,209 ft recovered 50 ft, or 99 percent, using a 6⅛ by 3½-in. corehead. It then took 5 rock bits and 72 hours rig time to ream this 50 ft of rat hole. Because there had been no difficulty in obtaining this first 50 ft core and because the penetration rate averaged 1.85 ft per hr, it was decided to full-hole core the remaining footage to be drilled in this well. An 8⅞ by 4⅜-in. corehead was run from 15,209 to 15,473 ft and averaged 2.78 ft per hour. The operator recovered 84 percent of the formation cut, providing excellent geologic information probably at less cost than if this remaining footage had been drilled with rock bits.

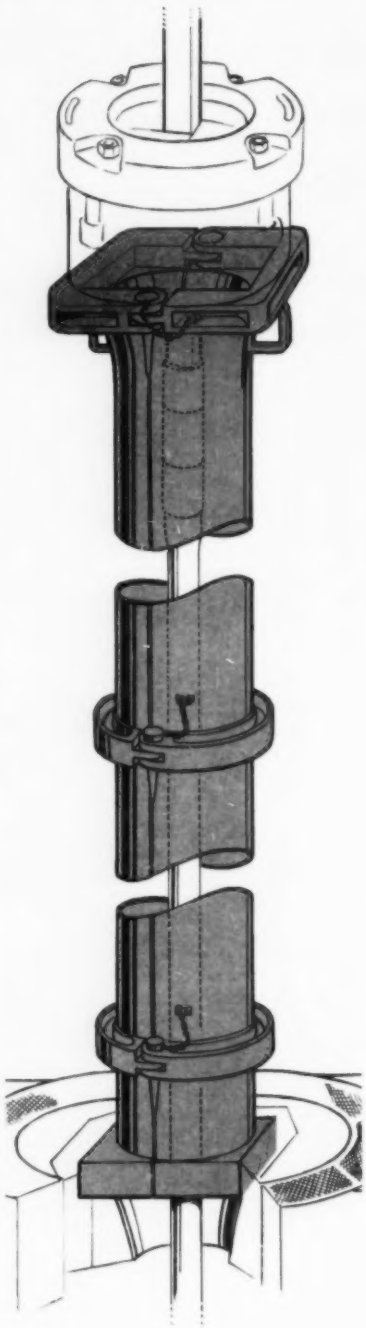


FIG. 1. **Kelly extension drive** makes it possible to core as much as 69 ft without making a drill pipe connection or interrupting any of the coring operation when used with a 40-ft kelly. The tool is hinged at 3 points with lock rings which have removable pins on one side for quick and easy installation and removal. The tool is available in either 20 or 30-ft lengths. The 30-ft tool weighs 2200 lb and is a recent development of Drilling and Service, Inc., Dallas, Texas.

Kelly Extension Drive

Making drill pipe connections during coring operations has always been hazardous and undesirable. Fig. 1 shows a new tool called a kelly extension drive that has been developed to make it possible to core as much as 69 ft without any interruption (to make a connection) of the carefully controlled operating conditions that are often necessary to maintain during coring operations. This tool is field proved and fits any standard API rotary bushing and table.

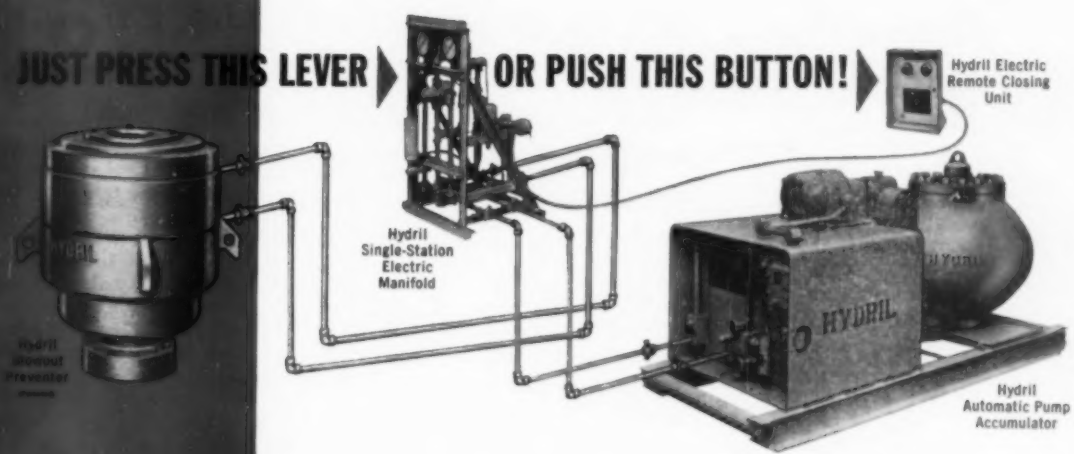
Diamond Tools and Techniques Improve

Many advances have been made in the art of diamond coring and drilling in recent years. These improvements in equipment and techniques have greatly increased the performance of all types of diamond coring and drilling equipment and have also greatly reduced overall costs of coring and drilling with diamond tools. Better designs now make it possible to deliver more fluid energy to the bit to create a greater pressure drop across the bit face. Recent mechanical developments have shown the best size of diamonds to use in a particular bit and the proper concentration of the diamonds for the greatest penetration rate and economy in the use of these valuable gems. The diamonds used must have certain desired qualities and they must be properly oriented in the bit face for maximum drilling efficiency.

Maximum efficiency in diamond coring or drilling operations requires a proper balance of rig equipment, hydraulics, diamond coring or drilling equipment, and full consideration of down hole conditions.

The diamond bit industry has made great strides in the recent years but no one will say that these tools have been developed to their highest proficiency. There is much optimism about the future of diamond drilling and especially in the promising and challenging field of slim hole drilling. ★ ★ ★

to TAME a kicking well...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The Digital Computer . . .
What It Means to the Engineer

PART 14

While removing the drudgery of repetitious details from the engineer, the modern digital computer will demand a return to fundamentals in the analysis of the engineer's problems

Paul W. Stade, Jr., *Reservoir Engineering Supervisor, Atlantic Refining Company, Dallas, Texas*

IN A FEW SHORT YEARS, the digital computer—one of the electronic wonders of the "second industrial revolution" has opened a whole new means of growth to the engineer and scientist. Although now used extensively, the application of computers is still in its infancy. In the future, use of computers promises far greater opportunity for the engineer to contribute to progress in all industries, and significantly so in the oil production field. We are faced with an increased demand for an engineering solution to all problems connected with the development and operation of oil and gas fields. To solve these problems requires that we find a more efficient, speedy and exact way to get at the answers. Computers are one means of doing this.

The automatic, high-speed digital computer is a very powerful tool. In many ways, it is completely reshaping the way businessmen and engineers alike perform their jobs, and it appears certain to have a significant influence on the future organizational structure of the business world we work in. This is amazing when we realize that the first of the modern-day electronic computers first operated just 12 years ago in 1947. In 1949, a semi-automatic computing system was available on a commercial basis, but the first truly automatic computers for commercial use did not appear until 1951. Since then the growth has been rapid. It is estimated that there are over 2000 computers in use, another 3000 on order, and by 1965, there will be 10,000 in use. There are about 20 different concerns manufacturing various kinds of computers for commercial use and some 35 different models of various sizes and costs available.

Although the growth in use of computers has been rapid, businessmen and engineers alike have only started to develop a mass understanding of what they can do and how they can be used. Why is this so? First, it is necessary to develop computing methods adaptable to a computer's capabilities. Second, to take full advantage of these capabilities, it is necessary to examine the fundamental basis of business and engineering work, how various functions and jobs are related, and how computers fit into the picture. This examination takes considerable time and study. Third, better computers and improved computing techniques are only beginning to contribute to universal use of computers in many types of work.

One all-inclusive feature that characterizes the use of digital computers and the way we solve problems with them is a "return to fundamentals." This includes the fundamentals of mathematical approaches to problems, to the source and relationship of basic data, of the relation of the various things we do in business, and, of most interest to us, the fundamentals of how an engineer can best do his job.

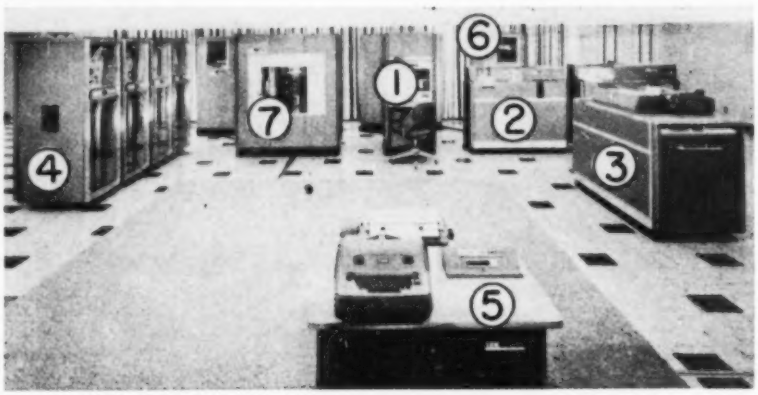

FIG. 1. Medium size computing system (IBM 650) consists of a console (1), a power unit (behind console), and a card read-punch unit (2). This basic system can be expanded, as shown, to include magnetic tape units (4), magnetic core storage (6), disk storage (7), inquiry stations (5), and accounting machines or printer (3).

What Is a Digital Computer?

In simple terms, a digital computer is a machine that can direct itself in solving arithmetic problems at high rates of speed. Usually in actual operation it is the main unit of a data-processing system (Fig. 1) which can also arrange and store basic data and provide printed reports in a usable form.

To make high-speed computation, the data processing system must provide for three basic operations (Fig. 2): (1) data input, (2) data processing, and (3) data output. The digital computer does the data processing. In more technical terms it can be called an auto-

matic, high-speed, electronic, digital data-processing machine.

What do these terms describe?

1. **Data processing** tells what the machine does. A computer is primarily an information handling machine; therefore, it must be able to store information within itself. To do this the computer has a storage unit or memory which retains in a coded form the information to be processed, the directions for doing the processing, and the results developed in the process. The directions for doing the processing are called the *program*. The program is a predetermined series of "instructions" which describe the problem to be solved in codes and numbers understood by the computer. Because the instructions are stored within the computer, the computer is called an "internally-stored program" machine. Each one of the pieces of information or program steps is represented by a number (usually 10 digits or less in length) called a "word." Words are stored at specific locations or "addresses" in the storage unit where they are available for use as needed.

There are a variety of storage devices utilized in computers. Typically, a computing system will use more than one type of storage device depending on the characteristics of the device and the computing demands. The three most important characteristics of storage devices are: (1) access time, which is the speed with which a computer can refer to its storage unit; (2) capacity, or the number of words the storage unit can contain, (3) cost, usually on a cost per word basis.

The storage devices usually are divided into primary, auxiliary, and external memories. The primary memory is an "internal" storage device which exchanges information directly with the arithmetic and logic unit in actual solution of problems. Information from other memory units must be transferred to the primary memory before the information can be used in computation. The auxiliary or intermediate speed memory is often used to store frequently-used constants or similar reference information. The external memory is generally a permanent, low-speed storage unit used to store large volumes of information that are regularly or periodically operated on by the computer. Usually advantage is gained in one characteristic of a storage device at some sacrifice in the others. Typically a quick-access, low-capacity, high-cost device will be used for internal storage and one or more slower-access, higher-capacity, lower-cost devices for external storage.

Some of the most common storage devices are:

Magnetic drum (Fig. 3). The magnetic drum is a common storage device often used as the primary or auxiliary memory unit. Words are written on the surface of the drum in the form of magnetic spots. When in operation, the drum rotates at high-speed past "read" and "write" heads which extract or enter the data words. Magnetic drums commonly hold 2000 to 4000 ten-digit words on their surface.

Magnetic cores (Fig. 4). Magnetic cores consist of a matrix of small doughnut-shaped rings of ferromagnetic material which can be charged to represent 0 or 1 and thereby represent numbers by a binary numbering system.* Core storage provides quick-access and moderately-high storage (4000 to 30,000 words) and is fairly expensive. It is very useful for internal storage.

Magnetic tapes. Magnetic tape units store data in the form of magnetized spots on reels of metal or metallic coated plastic tape. The reels are run past a read-write head to enter or extract data. Tapes are usually 1200 to 2400 ft in length and typically hold 200,000 ten-digit words per reel. Tape storage is very useful as an external storage device for storing a large amount of data.

Magnetic disk (Fig. 5). Magnetic disk storage consists of a series of thin

*For a good description of numbering systems used in computer design, see Reference 1, pages 254-269.

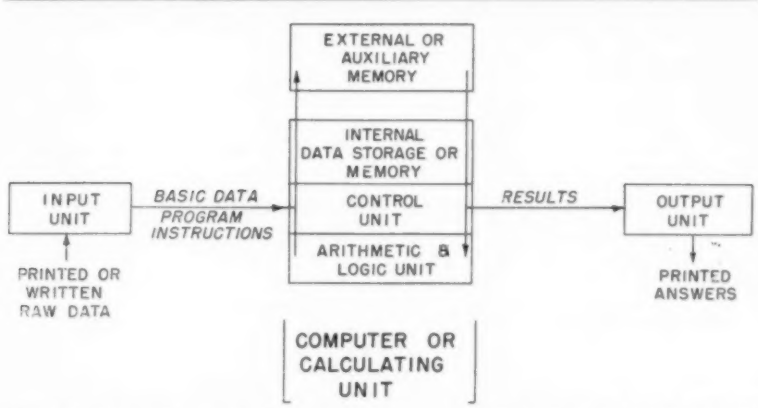

FIG. 2. Basic operations of data-processing system includes facilities for data input, data processing, and data output.

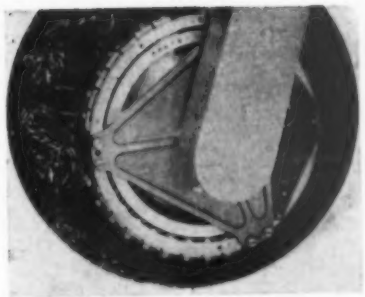

FIG. 3. Magnetic drum stores information in the form of magnetized spots on the surface of the drum. In operation, the drum rotates past "read" and "write" heads which extract or enter data words.

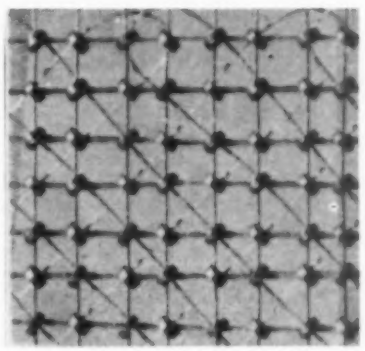

FIG. 4. Magnetic cores store data by being charged to represent 0 or 1, thereby representing numbers by a binary numbering system.

FIG. 5. Magnetic disk storage consists of thin magnetic coated disks separated and stacked around a common shaft. Data are recorded on the surface of the disks and read by one or more movable arms.

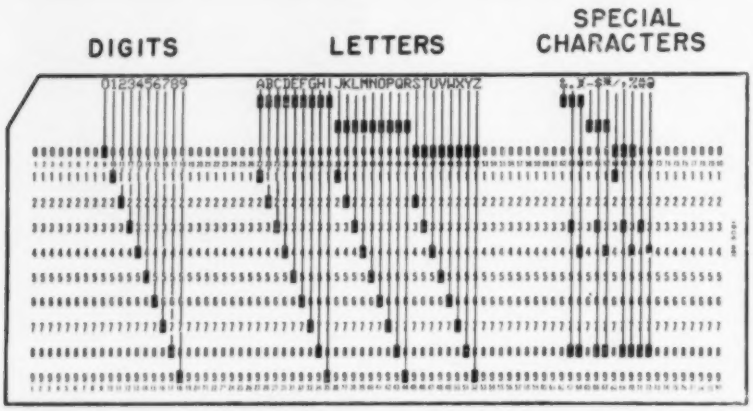

FIG. 6. Punched cards permit unlimited storage of data, but cannot provide data at high speed to a computer while it is calculating. Cards are therefore usually used in conjunction with some other system for actual computing.

magnetic coated disks arranged in record player fashion around a common shaft. Data are recorded on the surface of the disks and read by one or more movable arms. Magnetic disks provide a moderate speed, moderate cost form of storage and are useful where data are stored or used in a random manner.

Punched cards (Fig. 6). Punched cards are probably the best known form of external data storage. Although as much capacity as desired can be provided by merely using more cards, they cannot provide data at high speed to a computer while it is calculating. Therefore, other machines usually take data or instructions from the cards and transpose it to another storage device for actual computing. A whole family of machines are used to sort, arrange, and print data on punched cards. These machines are the main part of many data-handling systems for accounting or other clerical jobs in which little or rather extensive use may be made of a computer.

2. **Digital** defines the fact that the computer uses numbers or digits to do its job. It performs arithmetic and logical operations in its arithmetic unit. The arithmetic performed by the computer consists of only add, subtract, multiply and divide operations. A logical operation describes the "decision-making" ability of a computer. This is exemplified by the built-in ability of a computer to subtract (in effect, compare) two numbers and follow one line of operation if the difference is plus and another if it is minus.

3. **Electronic** is used because the major operating components are electronic circuits. These circuits operate in a highly reliable manner and the accuracy of computers is very high and considerably greater than normal human accuracy.

4. Most computers operate at **high speeds.** This can be measured in several ways, but one common criterion is the speed of addition. Some computers can perform 200,000 additions per second. Probably 600 additions per second closely describes the speed of most medium size computers.

5. Last, the term **automatic** describes the ability of a computer to guide and control itself during the course of its data processing action. To do this, the computer has a control unit which obeys the program instructions in proper sequence and causes the computer to function accordingly. The control unit directs data into the storage unit, it directs data from the storage unit to the arithmetic unit and tells the arithmetic unit which operation to perform, it returns the answer to the storage unit, and it directs reading of data and printing of results.

Besides the digital computer segment of our data processing system, there are the data-input and data-output devices for providing information to the computer and providing results in a readable form. Raw data can be typed directly into punched cards, magnetic tape and other storage devices or converted from cards to tape, cards to core storage, etc., using appropriate machines. Also, machines can receive results from the computer and rapidly print final reports.

Because of the importance of data input and output, the programer must concern himself with organizing his basic data so that it can be efficiently transcribed by input machines. It is desirable to keep the data as simple as possible. What we want to do is let the machines take simple tabulations, rearrange them into more complex form and then perform calculations with them. This points to mechanization of data handling from first inception of the data itself. In the oil business, for instance, it might involve automatic recording of oil and gas production data in the field and no further human handling until a desired final report is prepared. For routine engineering problems, standard basic data forms facilitate the process of transcribing data into the storage units.

Similarly, for data output, organization is of great importance. After the computer has accurately solved a long and complicated problem, it would be foolish to have the results copied or rearranged by humans where errors could result, if we can avoid it. We want machines to do the final arranging of data and printing of the final report.

From the foregoing discussion you can see that the abilities of a data processing system as to size, speed, and, therefore, cost can vary. In actuality, they vary quite a bit, and we have general categories of computing systems known as small size, medium size, and large size. Small is usually in a price range of less than $100,000; medium

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He joined The Atlantic Refining Company in 1948 as a reservoir engineer for the West Texas-New Mexico area and was later head of the special problems section of the reservoir engineering group. After serving at a naval fuel depot during the Korean War in 1951 and 1952, he returned to Atlantic and early in 1959 was named supervisor of the reservoir engineering group.

from $100,000 to $700,000, and large over $700,000. A company normally rents (or it may purchase) the size system that fits its operation at the time and, as a larger system is needed, it turns the old one in and gets a larger size. This changeover is usually a major step involving much reorganization and cost. Therefore, there is a current trend toward use of a computing system that starts at a certain minimum size and can be added to — such as adding additional external storage units — as needs increase.

How to Use a Computer

In order to use a computer the most important step is preparation of the computer program. Without deemphasizing their importance, it is also necessary to arrange suitable data input and output operations. Another step is actual operation of the system. While the programer should be acquainted with the operational phase of the job, once routine procedures are developed, it becomes of less importance to him and can largely be handled by a permanent operating staff.

Preparation of the computer program involves breaking down the problem you want to solve into a sequence of simple, basic steps and then preparing a series of "instructions" which cause the computer to carry out the program steps in the correct order. In its most basic form, programing is done in "machine language." This is the language or series of coded instructions that the machine was built to recognize. Each instruction specifies a particular step in the computing process and each one uses standard "commands" or operating codes which define the operating capabilities of the computer. For instance, a command may be "to transfer a number from location x of the storage unit to the arithmetic unit" or "add a number in location y of the storage unit to the number now in the arithmetic unit." There is generally a different set of commands for every computer, and a machine language program developed for one computer may not be usable on another.

The job of programing can be broken down into four specific tasks:

Write a formula. The first step is to set forth a clear, complete, detailed statement of what the computer is expected to do. A mathematical formula is usually the best way to do this because the precise and logical thinking required to express a job in mathematical terms usually forces careful consideration of all the alternatives involved. In doing this, every eventuality must be provided for because the computer itself cannot take courses of action which the programer has not foreseen or provided for.

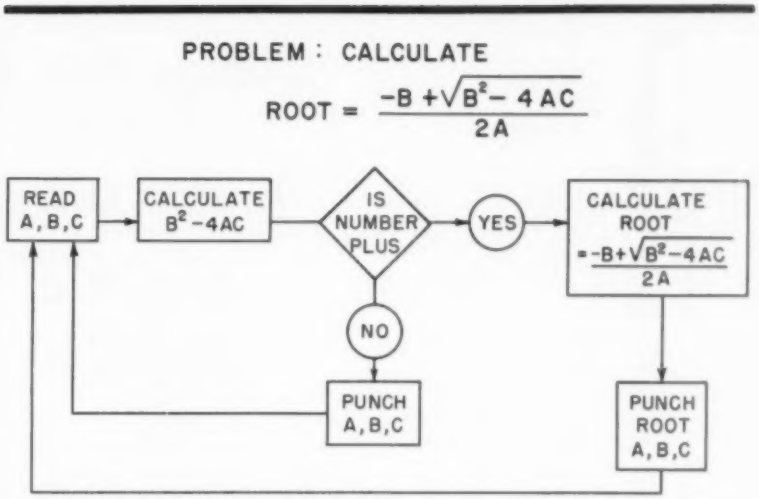

FIG. 7. Simple flow diagram illustrates the steps taken by a computer in the solution of a simple problem, following instructions previously entered in the machine.

Flow diagram. The second step is to prepare a rough picture of what the computer is expected to do in the time sequence it will do it. This is commonly called a block or flow diagram (Fig. 7). By reading the flow diagram one sees the steps the computer will follow in solving the problem. The flow diagram is particularly useful in specifying all the alternate courses of action that might develop during solution of the problem.

Write the instructions. This is transferring the operation specified by the flow diagram into a series of written code words or numbers that specify the machine operations to be performed. The code words or numbers can be recognized by the input unit and entered into the computer. One block on the flow diagram may represent many instructions. Part of this task is deciding where data to be used in the calculation should be stored in the memory unit.

Debugging. This is testing the program to see if it works on a sample case. Usually on long problems the first trial will not work and, oftentimes, many changes in the program may be necessary.

The standard machine language commands for any computer are primarily those basic to getting the calculating job done. Use of a few short,

IBM 650 MACHINE LANGUAGE PROGRAM FOR A+B=C

OBJECT: READ A & B FROM CARD; PUNCH ANSWER C INTO CARD

INSTR NO.	LOCATION OF INSTRUCTION	OPERATION ABBRV.	OPERATION CODE	ADDRESS DATA	ADDRESS INSTRUCTION	REMARKS
1	0001	RD	70	0051	0002	Read a Card
2	0002	RAL	65	0051	0003	Reset & Add to Arithmetic Unit
3	0003	AL	15	0052	0004	Add to Arithmetic Unit
4	0004	STL	20	0077	0005	Store Arithmetic Unit in 0077
5	0005	PCH	71	0077	0001	Punch 0077

IBM 650 MACHINE LANGUAGE PROGRAM FOR A x B=C (No Decimals)

OBJECT: READ A & B FROM CARD, PUNCH A, B, & ANSWER C IN CARD

INSTR NO.	LOCATION OF INSTRUCTION	OPERATION ABBRV.	OPERATION CODE	ADDRESS DATA	ADDRESS INSTRUCTION	REMARKS
1	0001	RD	70	0051	0002	Read a Card
2	0002	RAU	60	0052	0003	Reset & Add to Arithmetic Unit
3	0003	STU	21	0079	0004	Store Contents of Arith. Unit in 0079
4	0004	MULT	19	0051	0005	Multiply
5	0005	STD	24	0078	0006	Store Number Used to Multiply in 0078
6	0006	STL	20	0077	0007	Store Product in 0077
7	0007	PCH	71	0077	0001	Punch 0077, 0078, 0079

FIG. 8. Machine language commands for two simple arithmetic operations are illustrated here. The addition of two simple numbers (above) requires five steps. Multiplication of two simple numbers (below) is done in seven steps.

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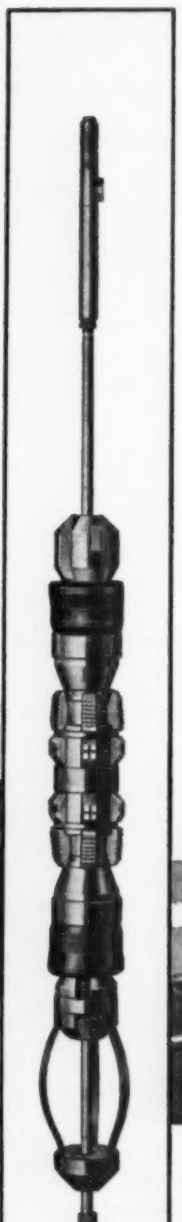

BAKER RETRIEVABLE BRIDGE PLUGS are dependable, and they hold pressure from either direction. Used alone for plugging casing temporarily under routine or emergency condition, or in combination with other Baker RETRIEVABLE Tools to straddle a virtually unlimited interval. Call for Product No. 677-C.

BAKER FULL-BORE TUBING TESTERS are run with Baker FULL-BORE Retrievable Cementers for safe testing of tubing immediately before squeezing. Right-hand rotation required for setting the Cementer, serves to unlock the Tester Valve; set-down weight closes it; picking-up after testing restores full-opening through the Tester. Call for Product No. 672-N.

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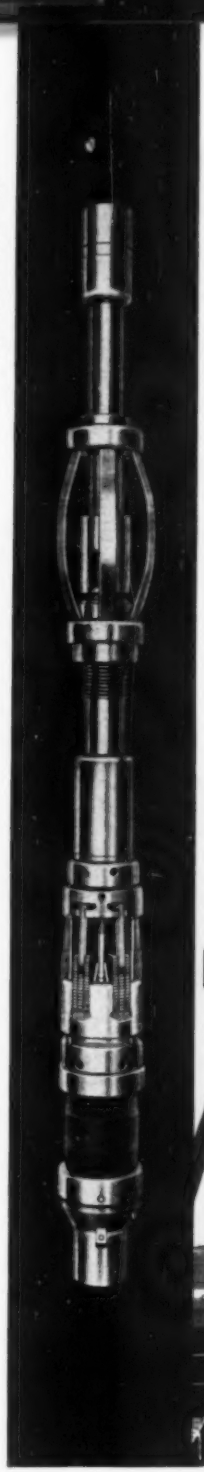

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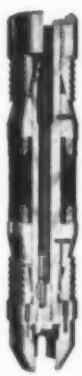

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simple commands that can be used over and over conserves computer size but makes programing more difficult. More and longer commands add to the complexity and cost of the computer. In either case programing in machine language can be very detailed. For instance, in one of the popular medium size computers in order to place two numbers in the computer, add them together, and provide the answer requires a program consisting of the following instructions:

1. Read (from a punched card) numbers A and B into storage addresses X and Y;
2. Place number A in the arithmetic unit;
3. Add number B into the arithmetic unit;
4. Store contents of the arithmetic unit (now A and B) in address Z of the storage unit;
5. Read (into a punched card) contents of storage address Z.

In addition, certain rules of which storage addresses to use for each number must also be followed, and the size of the numbers must be considered in preparing the above program. This program in coded form is shown on Fig. 8.

On this same computer to multiply A times B to give product P and to provide a punched card answer containing A, B and P requires seven steps (Fig. 8); that is, seven steps if you are dealing with small size whole numbers. If we were using fractional numbers, extra steps would be required to keep the decimal point in place.

For more complicated programs, the number of instructions expands very rapidly. For instance, one program for taking the square root of a number requires 69 instructions. Some time ago, we wrote a program for the recovery performance of a solution-gas drive pool. It took 1430 instructions.

The actual computing time to solve these and many more complicated programs is not of primary concern. For instance, the solution-gas drive performance calculation takes about eight minutes per case. Of course, if you were doing 500 of them a week, then it would be important to cut the computing time. And you would have good reason to use a larger computer which could do the job much faster. Similarly, some lengthy problems using detailed numerical analysis procedures may be entirely unsuitable for any but the largest size computers.

What is of more concern to the programer is the fact that he must go through so much detail in translating his flow diagram into machine language instructions. Of course, once it's done, the program can be used over and over again without reprograming it. But, even so, the computer would be of much more practical use if the task could be simplified. Two general means of simplifying the job have been developed.

Sub-routines. Whenever a special technique, such as the square root example, has been programed, it can be used whenever needed as a part of larger programs without reprograming it. One common way of taking advantage of a number of standard subroutines so developed is to place all of them in the computer storage unit where by proper instructions any one or more of them can be used. This is the basis of so-called "interpretive" systems.

Automatic programing. This technique gets closer to the ultimate. Since machine language programing follows a detailed set of rules, can the machine itself by following a fewer number of simple commands be made to follow these rules? This is done by what is known as "automatic coding" or "automatic programing." In automatic programing, the programer uses special code words or commands which the computer will translate into machine language instructions. These special commands are written in a manner closely similar to the way the basic formula is written in the first place.

In current automatic programing systems there are still many rules to follow, but the rules are more related to the basic flow diagram of the program itself and the drudgery of writing all the machine language commands is handled by the computer.

Automatic coding techniques, to date, have found much more use in scientific and technical fields than in general business and accounting use, apparently, because of the more straight-forward logical formulation of scientific and technical calculations. But according to one authority in the field[9], "if electronic data-processing is ever to become an automatic, instantaneous, information source for business management, methods of automatic programing and automatic information control must be developed to a degree that can hardly be imagined today." In technical fields, automatic programing offers the engineer an opportunity to extend use of the computer to the small but time consuming and voluminous parts of his everyday work that otherwise could not be practically handled by the computer.

Automatic programing offers two additional advantages. First, because of the fewer commands used, it is easier to change or modify a program. Secondly, because the instructions are more general, the commands used may be applied to more than one computing system. This tends to eliminate the need for complete rewriting of your program if you move to a larger size computer. Some day a general automatic coding system applicable to all computers may be developed.

What to Use Computers For

In determining what jobs can be performed satisfactorily by a computer, three general factors can be considered:

1. Reduction in clerical costs;
2. Development of better management control information or performance of technical calculations too costly or impractical to obtain by conventional methods;
3. Introduction of new techniques.

Each of these is of importance to a programer and offers him an opportunity for wide application of his talents.

Clerical functions. In both business and technical fields, costly or lengthy clerical tasks are usually the first job performed by computers. Generally, attractive areas for use of the computer are where clerical costs are the highest. This is exemplified by the widespread use of computers for many accounting, inventory, and general record keeping functions. For the engineer, reduction in clerical work means that he can spend less time waiting to have his calculations performed by hand or doing them himself and more time in analyzing the results and advising management of their significance. Also, his work will have fewer errors.

Development of information not otherwise possible. In this area we begin to realize the true potential of the computer. Whereas in the first category we are usually concerned with improving the current way of doing things, here we are concerned with doing things in a more complete and improved way. Because of its ability to handle large volumes of data at high speed, the computer can be used to analyze problems in more detail and with fewer simplifying assumptions. The engineer, as a result, can use improved technical methods that otherwise would be impractical. He can examine many more alternate solutions to a problem and consequently arrive at better conclusions. And, of great importance, he can do this in sufficient time to make the results available for everyday business decisions. Management is thus provided with a sounder, more scientific basis for deciding what to do.

All this, however, places much greater demands on the engineer. He cannot be satisfied with applying old methods to his problems. Since he has better tools and techniques available, he must seek to understand more of the "why" of his work. He must understand the fundamental factors controlling his problems and must devise new ways of analyzing these problems and

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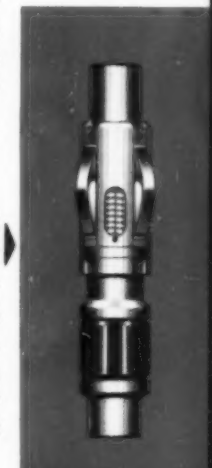
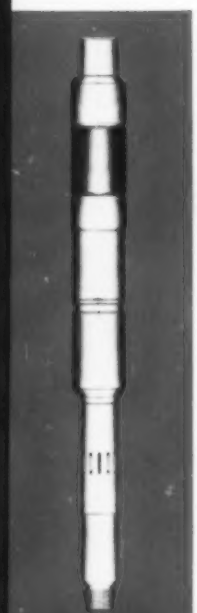


TYPE RA OTIS RETRIEVABLE PACKER

The Type RA Otis Retrievable Packer is a compact, economical production packer that can be used in treating, fracturing, or water flooding operations, as well as in producing wells. It may be set in tension or compression without modification.

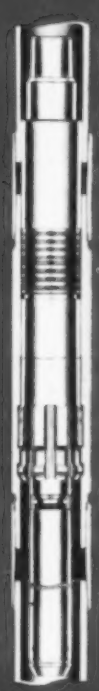


TYPE HS OTIS RETRIEVABLE ISOLATION PACKER

The Type HS Otis Retrievable Isolation Packer is designed to be set hydraulically by pressure from within the tubing and then held expanded by a mechanical lock. Any number of these packers can be made up and run in on a single string of tubing, and then set and tested individually.

OTIS RETRIEVABLE SLIM-HOLE COLLET-TYPE PACKER

The Otis Retrievable Slim-Hole Collet-Type Packer is designed for use in permanent-type, tubingless well completions and in wells where high pressures and/or temperatures pose a problem. The packer may be run, set, pulled, and reset in different nipples located in the pipe, by wire line methods.



TYPE BC OTIS WIRE LINE BRIDGE PLUG

The Type BC Otis Wire Line Bridge Plug is designed to provide a positive fluid shut-off from either direction in a well regardless of depth or pressure. The Otis Bridge Plug is shorter in length and has a smaller O.D. than other bridge plugs now in use which means less material to be drilled when the plug is removed.

OTIS RETRIEVABLE CASING COLLET-TYPE PACKER

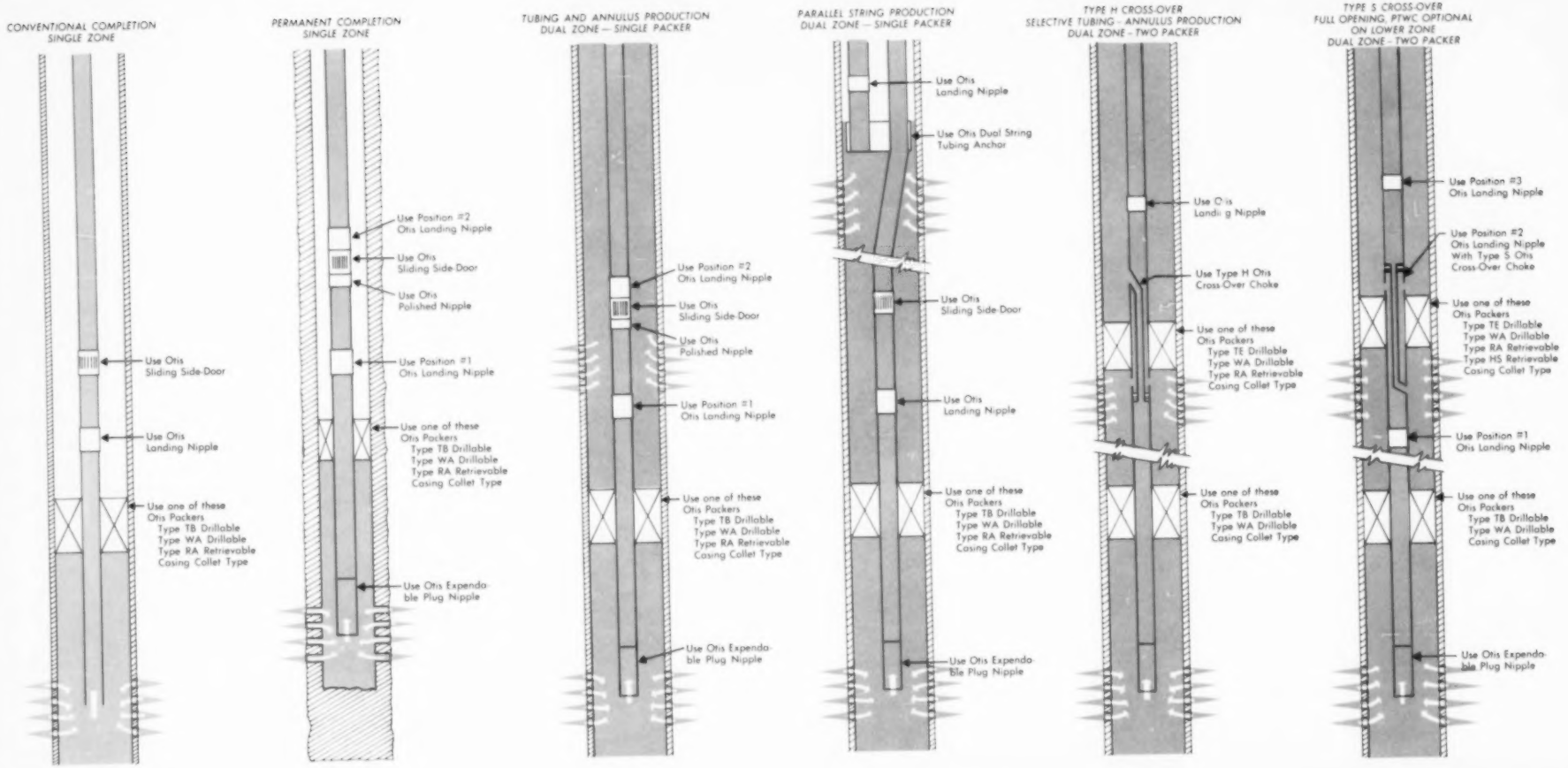
The Otis Retrievable Casing Collet-Type Packer is ideally suited to wells where high pressures and/or temperatures make the use of slip-type packers impractical, where the packer must be moved often, or in crooked or directional holes. The packer may be run, set, and retrieved on the tubing or by wire line methods.

PRESSURE CONTROL · OTIS · SERVICE · EQUIPMENT

OTIS ENGINEERING CORPORATION

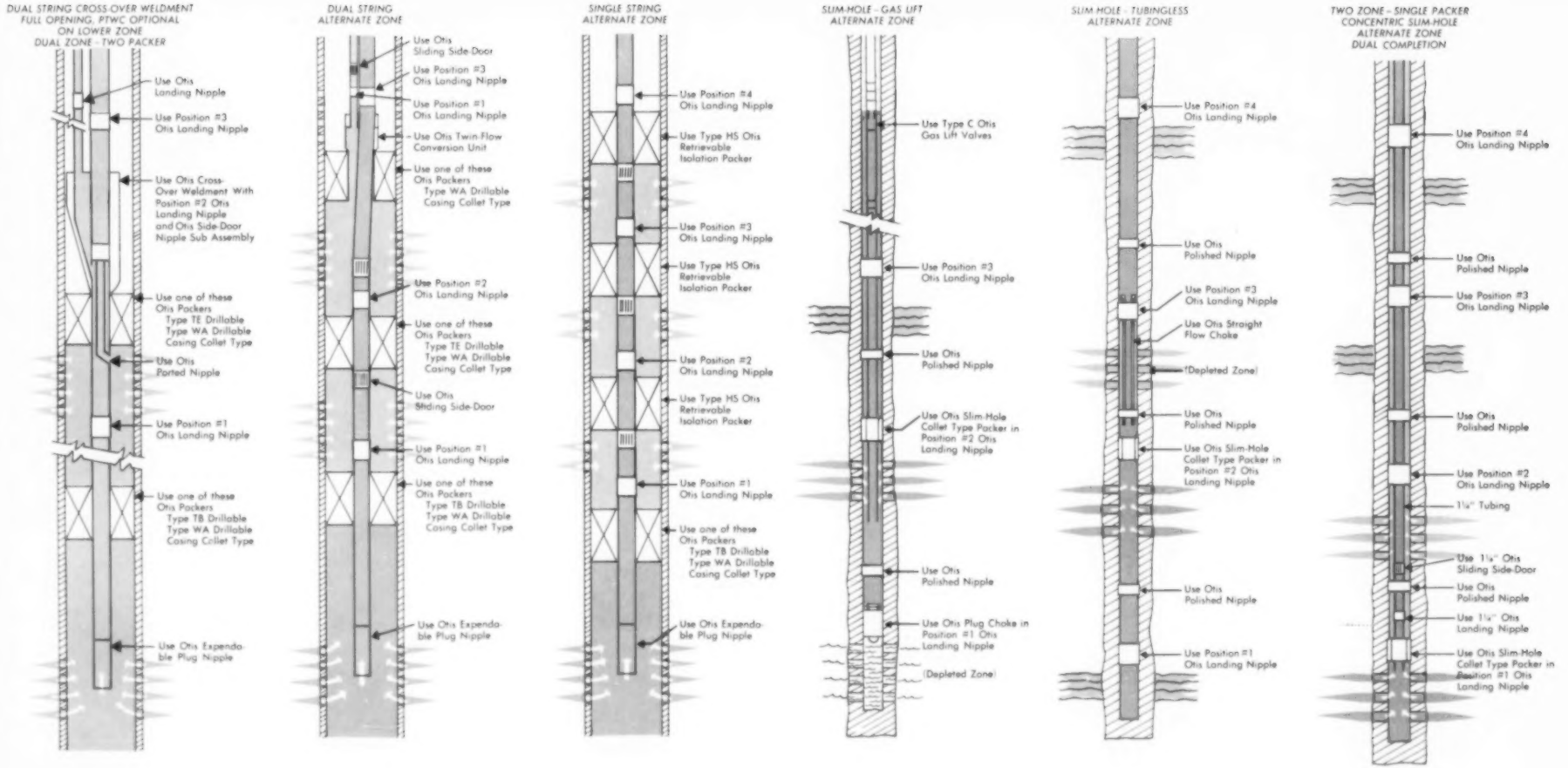
PRODUCTION HOOKUPS

When and Where You Can Use Otis Packers and Production Tools in Conventional, P.T.W.C., Dual-Zone, Alternate Zone, and Slim-Hole Completions


CONVENTIONAL COMPLETION
SINGLE ZONE
Use Otis Sliding Side-Door
Use Otis Landing Nipple
Use one of these Otis Packers Type TB Drillable Type WA Drillable Type RA Retrievable Casing Collet Type
PERMANENT COMPLETION
SINGLE ZONE
Use Position #2 Otis Landing Nipple
Use Otis Sliding Side-Door
Use Otis Polished Nipple
Use Position #1 Otis Landing Nipple
Use one of these Otis Packers Type TB Drillable Type WA Drillable Type RA Retrievable Casing Collet Type
Use Otis Expendable Plug Nipple
TUBING AND ANNULUS PRODUCTION
DUAL ZONE — SINGLE PACKER
Use Position #2 Otis Landing Nipple
Use Otis Sliding Side-Door
Use Otis Polished Nipple
Use Position #1 Otis Landing Nipple
Use one of these Otis Packers Type TB Drillable Type WA Drillable Type RA Retrievable Casing Collet Type
Use Otis Expendable Plug Nipple
PARALLEL STRING PRODUCTION
DUAL ZONE — SINGLE PACKER
Use Otis Landing Nipple
Use Otis Dual String Tubing Anchor
Use Otis Sliding Side-Door
Use Otis Landing Nipple
Use one of these Otis Packers Type TB Drillable Type WA Drillable Type RA Retrievable Casing Collet Type
Use Otis Expendable Plug Nipple
TYPE H CROSS-OVER
SELECTIVE TUBING - ANNULUS PRODUCTION
DUAL ZONE - TWO PACKER
Use Otis Landing Nipple
Use Type H Otis Cross-Over Choke
Use one of these Otis Packers Type TE Drillable Type WA Drillable Type RA Retrievable Casing Collet Type
Use one of these Otis Packers Type TB Drillable Type WA Drillable Casing Collet Type
TYPE S CROSS-OVER
FULL OPENING, PTWC OPTIONAL
ON LOWER ZONE
DUAL ZONE - TWO PACKER
Use Position #3 Otis Landing Nipple
Use Position #2 Otis Landing Nipple With Type S Otis Cross-Over Choke
Use one of these Otis Packers Type TE Drillable Type WA Drillable Type RA Retrievable Type HS Retrievable Casing Collet Type
Use Position #1 Otis Landing Nipple
Use one of these Otis Packers Type TB Drillable Type WA Drillable Casing Collet Type
Use Otis Expendable Plug Nipple

OTIS ENGINEERING CORPORATION

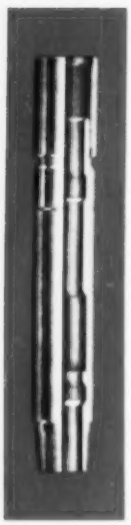
Branches Throughout the Oil Country


DUAL STRING CROSS-OVER WELDMENT
FULL OPENING, PTWC OPTIONAL
ON LOWER ZONE
DUAL ZONE - TWO PACKER
Use Otis Landing Nipple
Use Position #3 Otis Landing Nipple
Use Otis Cross-Over Weldment With Position #2 Otis Landing Nipple and Otis Side-Door Nipple Sub Assembly
Use one of these Otis Packers Type TE Drillable Type WA Drillable Casing Collet Type
Use Otis Ported Nipple
Use Position #1 Otis Landing Nipple
Use one of these Otis Packers Type TB Drillable Type WA Drillable Casing Collet Type
Use Otis Expendable Plug Nipple
DUAL STRING ALTERNATE ZONE
Use Otis Sliding Side-Door
Use Position #3 Otis Landing Nipple
Use Position #1 Otis Landing Nipple
Use Otis Twin-Flow Conversion Unit
Use one of these Otis Packers Type WA Drillable Casing Collet Type
Use Position #2 Otis Landing Nipple
Use one of these Otis Packers Type TE Drillable Type WA Drillable Casing Collet Type
Use Otis Sliding Side-Door
Use Position #1 Otis Landing Nipple
Use one of these Otis Packers Type TB Drillable Type WA Drillable Casing Collet Type
Use Otis Expendable Plug Nipple
SINGLE STRING ALTERNATE ZONE
Use Position #4 Otis Landing Nipple
Use Type HS Otis Retrievable Isolation Packer
Use Position #3 Otis Landing Nipple
Use Type HS Otis Retrievable Isolation Packer
Use Position #2 Otis Landing Nipple
Use Type HS Otis Retrievable Isolation Packer
Use Position #1 Otis Landing Nipple
Use one of these Otis Packers Type TB Drillable Type WA Drillable Casing Collet Type
Use Otis Expendable Plug Nipple
SLIM-HOLE - GAS LIFT ALTERNATE ZONE
Use Type C Otis Gas Lift Valves
Use Position #3 Otis Landing Nipple
Use Otis Polished Nipple
Use Otis Slim-Hole Collet Type Packer in Position #2 Otis Landing Nipple
Use Otis Polished Nipple
Use Otis Plug Choke in Position #1 Otis Landing Nipple
(Depleted Zone)
SLIM-HOLE - TUBINGLESS ALTERNATE ZONE
Use Position #4 Otis Landing Nipple
Use Otis Polished Nipple
Use Position #3 Otis Landing Nipple
Use Otis Straight Flow Choke
(Depleted Zone)
Use Otis Polished Nipple
Use Otis Slim-Hole Collet Type Packer in Position #2 Otis Landing Nipple
Use Otis Polished Nipple
Use Position #1 Otis Landing Nipple
TWO ZONE - SINGLE PACKER CONCENTRIC SLIM-HOLE ALTERNATE ZONE DUAL COMPLETION
Use Position #4 Otis Landing Nipple
Use Otis Polished Nipple
Use Position #3 Otis Landing Nipple
Use Otis Polished Nipple
Use Position #2 Otis Landing Nipple
1¼" Tubing
Use 1¼" Otis Sliding Side-Door
Use Otis Polished Nipple
Use 1¼" Otis Landing Nipple
Use Otis Slim-Hole Collet Type Packer in Position #1 Otis Landing Nipple

Call Otis – for Complete Well Completions!

PRESSURE CONTROL · OTIS · SERVICE – EQUIPMENT

These OTIS production tools can help solve your completion problems



LANDING NIPPLES

The Otis Selective Landing Nipple is one of the most essential pieces of equipment in use today for producing flowing oil and gas wells. It provides a positively-located seat for landing the many Otis sub-surface flow control tools which have proved so necessary to efficient oil and gas well production and remedial operations.

Otis Selective Landing Nipples are available in two different types — the Type S and the Type T — for practically any size tubing and with any type thread. The primary difference between the two nipples is that the Type T has a smaller I.D., which permits its use with heavy-walled tubing or with regular E.U.E. tubing below sub-surface equipment that reduces the I.D. of the tubing.

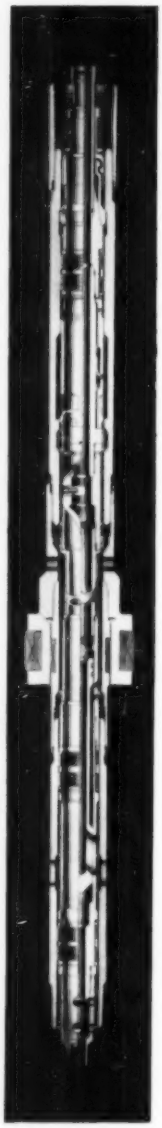
The Types S and T Otis Landing Nipples are available for use with 1.660" through 4½" O.D. tubing. Both are less than collar O.D. of regular E.U.E. tubing and the same as, or less than, the O.D. of the upset on flush-joint tubing.

SLIDING SIDE-DOORS

The Otis Sliding Side-Door is a circulating tool which permits selective communication between the tubing and the annulus. It is designed to be opened or closed as desired by wire line methods — under pressure, without killing the well, and without disturbing the packer setting. The tool is designed so that any number of Sliding Side-Doors may be made up in the tubing string and any or all can be opened or closed in a single run of a wire line shifting tool.

The Otis Sliding Side-Door is ideally suited to installation in two-zone and alternate-zone completions as it permits the selective production of any zone as it becomes desirable. The vertical slotted ports are designed to provide maximum strength and at the same time prevent distortion of the tool when it is subjected to the stress and torque of the production string.

Otis Sliding Side-Doors are available for use with 1.660" through 3½" O.D. tubing and may be supplied with any type thread.



SELECTIVE CROSS-OVER NIPPLE ASSEMBLY

for conventional or P.T.W.C. two-zone wells

The Otis Selective Cross-Over Nipple Assembly can save you the cost of a second string of tubing and a dual packer on dual producers, and at the same time provide all the necessary selectivity to produce your wells efficiently. The assembly not only affords selective tubing-annulus production of two-zone wells but permits various types of remedial operations to be performed on either zone without disturbing the packer settings. The assembly is available for use with 1.900" through 2⅞" O.D. tubing.

There are 10 different Otis chokes available for use in this selective cross-over hookup. These chokes include the regular cross-over choke to produce the lower zone through the annulus while the upper zone is produced through the tubing; a regular straight-flow choke to keep the lower zone in the tubing and the upper zone in the annulus; a dual side-door choke and a dual separation tool which permits the blanking off of either upper or lower zone and/or the annular space above the packer; an upper zone acidizing tool and a lower zone acidizing tool to permit the treating of either zone independently of the other; an upper zone ring check and a lower zone ring check which makes it possible to treat either zone without exposing the casing to treating pressure and yet permits circulating out following the treatment; a circulating tool which allows the well to be circulated with both zones blanked off, and a regular plug choke designed to plug off the tubing and withstand up to 10,000 p.s.i.

PRESSURE CONTROL - OTIS - SERVICE - EQUIPMENT

Have OTIS engineer your next well completion!

The next time you have a well completion problem, call your nearest Otis office. With more than a quarter of a century of experience in the research, design, and manufacturing of production control equipment — both sub-surface and surface — Otis has all of the knowledge and equipment necessary to help you engineer the proper well completion. Otis packers and flow-control equipment are precision-manufactured and carefully checked to make certain each tool conforms to design specifications. This is your assurance of receiving a quality product with each purchase.

OTIS ENGINEERING CORPORATION

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the large amount of data pertaining to them. Finally, he must resolve the results into clear-cut and sound bases for good business decisions.

New techniques. Both in the management of business and in the field of engineering there is a crying demand for new ways of doing things. As an example, if a management decision depends on a comparison of many alternate courses of action or variables too complicated to analyze by standard hand calculating methods, it might be possible for the computer to make the best decision considering all the variables if a programer can devise the program and know what data to put into it. There are a number of mathematical techniques used to do this.

In technical fields there are cases where no practical form of research or study of a process or technique has been feasible before computers were available. Here a development might be said to be a direct result of the computer.

What both of these examples call for in the engineer or programer is more creative thinking. If he hits upon a new thought or idea and can express it by a formula, no matter how complicated, he has the potential available to develop it into a practical result. As a result of the greater capacity for development provided by the computer, the time between research or discovery of new knowledge and practical application can be greatly reduced.

In general in all the above areas, problems handled by the computer can be broken down into data handling or technical categories. The data-handling problems embrace specific single studies and large routine clerical functions. The large clerical functions may require a detailed procedural or methods study to prepare the machine program and may concern the jobs of many people in several different departments.

Who Can Use the Computer?

Is there any limitation as to who can use a computer in his work? At present, there are some limitations depending on the type of work you do and where you do it. In the future, many or all of these limitations will disappear. In the oil production business we have barely scratched the surface in the widespread use of computers in engineering work.

What are some of the problems in this connection? First is the previously mentioned application of new methods. With the tremendous ability of the computer to perform calculations with more accuracy and detail, we need to develop better analysis methods. To realize the full potential of the computer there is little point in taking shortcuts in making a technical study. In the meantime, however, there are many technical methods that we now know can be used but we just can't use them in the time required for an answer. Many of these, once programed for the computer, can be considered as routine procedures.

The second problem is experience. An engineer is charged with planning operations and developing new and improved ways for carrying them out. To be more efficient in his work, he must learn to use the computer. He must learn what is required in preparing a computer program. This comes only with experience and effort and the realization that he must think harder to develop the detailed solutions to his problems that can be handled by the computer. Most practicing engineers today need to do far more of this type of thinking.

A third problem is communications and organization. Many companies today operate from decentralized locations. Usually, the engineers must avail themselves of a computer that is many miles away in a central office. In many respects, this problem can be solved merely by an engineer's determination that he wants to use the computer. Practically every company in the oil business has a central engineering staff that concerns itself with computers and who are charged with making this tool useful to the entire company engineering force. If the work developed becomes significant enough, a special communications system can be provided so the engineer can get his problem to the computer. But the engineer must show that it is needed by his determined use of the computer.

A fourth problem is application of the computer to the many small, time-consuming, and often routine tasks performed by the engineer. Many of these are simple calculating or small data handling jobs, each one of which may not justify a mechanized system for doing the work. However, as more applications are mechanized, the smaller jobs may be included relieving the engineer of the work. Here again, automatic programing also offers the engineer an opportunity to program small jobs that otherwise could not be programed fast enough or would not justify the effort.

Each one of these problems suggests that their solution includes two major factors: (1) A wider knowledge of computer programing and data handling techniques by the engineer, and (2) a determined effort to apply this knowledge to his work.

What Lies Ahead?

We have discussed several ways that computers will affect the work of the engineer in the future. These can be summarized as:

1. He will have to gain an understanding of what computers can do and how to use them.
2. He will have to develop more scientific and complete methods for solving his problems; this will require precise planning and considerable imagination on his part.
3. He will spend more time developing new concepts and approaches to his problems and the computer programs for applying them. New programing techniques will enable him to use the computer on a much wider range of problems.
4. He will be able to provide better answers quicker, answers which can be applied more immediately to day-to-day operations.
5. He will have available for his use a greatly increased amount of usable basic data. He will spend less time handling or comparing these data and more time in deciding the significance of the data and how to analyze it with the computer.
6. He will need to know more about the place of his work in the overall picture of the business he is part of. His work and that of others will be more integrated in many areas.

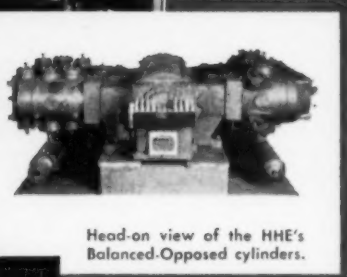
Surely these changes will create great demands on engineering and scientific talent and pose a challenge to all engineers. Their job will be harder because computers will increasingly downgrade the routine work of engineers and upgrade the creative work. And, since the time between creation and application will be shortened, he will be forced to create at a greater rate.

I recently read a quote[4] which I think sums up the situation very well: "We can all look forward to a future with fewer people doing the things machines can do, and more people doing the things that only people can do."

References

1. Chapin, Ned, *An Introduction to Automatic Computers*, D. Van Norstrand Co., Inc., Princeton, N. J., 1957.
2. Livesley, R. K., *Digital Computers*, Cambridge University Press, 1957.
3. Wallace, Frank, *Appraising the Economics of Electronic Computers*, Controllership Foundation, Inc., New York, N.Y., 1956.
4. "What Management is Learning From Computers," *Nation's Business*, November 1958, pp. 38-70.
5. "Electronics Will Open the Door to 'Optimization'," *Petroleum Week*, November 7, 1958, p. 81.
6. McCarty, D. G. and Welsh, J. R., "A Critical Study of a Petroleum Engineering Computing Operation," Paper 1088-G, Society of Petroleum Engineers Meeting, October 5-8, 1958, Houston, Texas.
7. Leavitt, H. J. and Whisler, T. L., "Management in the 1980's," *Harvard Business Review*, November-December 1958, pp. 41-48.
8. Bengston, R. J., and Smith, J. E., Jr., "Information Storage Devices: A Key to Automation," *Computers and Automation*, April 1958, pp. 11-13.
9. Hopper, Grace M., "Automatic Programing for Business Applications," *Computers and Automation*, February 1958, pp. 14-16. ★ ★ ★

THE PERFECTLY BALANCED OPPOSED



Head-on view of the HHE's Balanced-Opposed cylinders.

WILSON SUPPLY INGERSOLL-RAND HHE PACKAGED COMPRESSOR

WILSON SUPPLY
HHE
INGERSOLL-RAND

The new Wilson Supply HHE unit is a direct driven packaged compressor. It has been designed and fabricated to give the operator maximum flexibility, long life and peak performance.

It approaches perfect balance with opposed cylinders and sound over-all engineering.

Installation costs are less because vibration is practically eliminated with the HHE design. There is less wear and tear on the machine . . . less maintenance.

With "Controlled Clearance" liner-type cylinders (both low and high stage), the new Wilson Supply HHE unit is more flexible . . . can handle a wider range of applications than other units.

For complete information on the new Wilson Supply-Ingersoll-Rand HHE Packaged Compressor contact your nearest Wilson Supply Store or write: Compressor Department, Wilson Supply Company, P. O. Drawer 19, Houston, Texas. Please include suction, discharge and volume to be handled.

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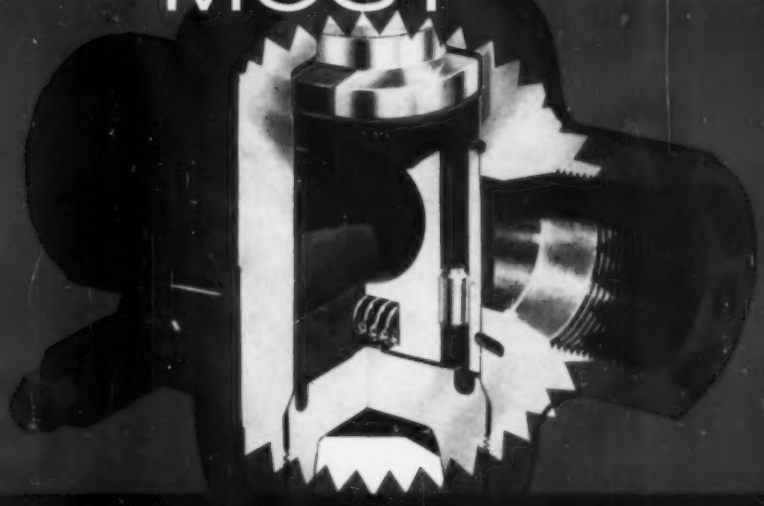

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TO SEAL AUTOMATICALLY

Not only is the Mission Valve always ready to seal, but the higher the pressure the tighter the seal. Line pressure forces Mission sealant through two semi-circular grooves around the downstream port, sealing like a plastic packing, to form a gas tight seal. Leaks are stopped *automatically* before they start. **The complete line** of 315 Mission Valves brings the positive advantages of easy opening and tight sealing to practically all valve applications. This wide selection, the Mission Guarantee, and the Mission Renewal Policy combine to make Mission Valves your best buy. Specify Mission and eliminate your valve problems.

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With new jet perforator . . .

Sonic Energy Produces Controlled Fracture

Jet-produced shock waves from an expendable wireline tool are employed to fracture producing formations in a predetermined, controlled plane

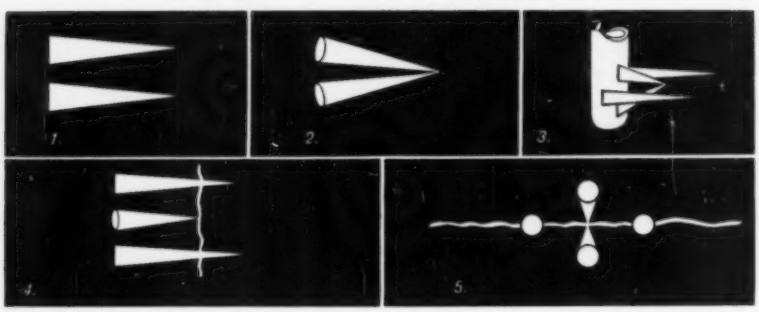

FIG. 1. **Parallel jets** (1) are used in conjunction with converging jets (2) in an arrangement (3) which produces the fracture in a controlled plane (4, 5).

DESPITE GREAT STRIDES in recent years in hydraulic fracturing technology, operators have indicated a need for more control in the fracturing operation. The recent trend toward fewer perforations and more selective exposure evidences general recognition of the fact that more efficient drainage of a producing zone is attained through a single large fracture rather than many small ones.

A new fracturing method which employs jet-produced shock waves was exhibited in Dallas recently at the Petroleum Branch, AIME, fall meeting. After extensive field testing in the Clinton Sand in Ohio, which is among the toughest of fracturing areas, the tool is being made available in all areas. It is an expendable wire line tool which exposes the formation and creates a horizontal fracture in a single operation.

The process, called Stereo-Frac, was developed by Bruce Gilbert, inventor of the FI process for The Western Company in 1956, and now president of Oil Tool Engineering Corp. in Dallas.

Many attempts to control the fracture plane have met with limited success. Also, efforts to eliminate the most hazardous and costly element in a fracturing operation — high breakdown pressure — have for the most part failed. Both operations are now accomplished in one simple operation. The new fracturing tool fires multiple jets which are so directed and timed that the resulting shock waves coact to produce a horizontal fracture in the formation adjacent to the well bore.

Theory of Operation

As the name of the process implies, high energy sound waves from several directions are employed. Design of the process is based on the fact that each jet, being supersonic, produces a shock wave as it penetrates. The energy in such compression waves dissipates rapidly but is extremely high near the source. Heavy crushing surrounding a jet perforation is telltale evidence of the shock wave intensity.

"Perforation diameter is a function of wave intensity which is a function of jet velocity," Gilbert says. A wave of still greater intensity results from the focusing of two jets upon a point of collision. It is the timed and directed collision of these characteristic waves from several jets which the tool employs to fracture earth formations.

Tool Design

Fig. 1 illustrates the arrangement of component jets. Two jets are directed into the formation along parallel axes lying in the desired plane of fracture. They are timed sufficiently in advance of two converging jets for their characteristic shock waves to be in the immediate vicinity at the time of collision of the converging jets. The coaction of these waves as they coincide produces a fracture. The resulting fracture extends beyond the perforations both

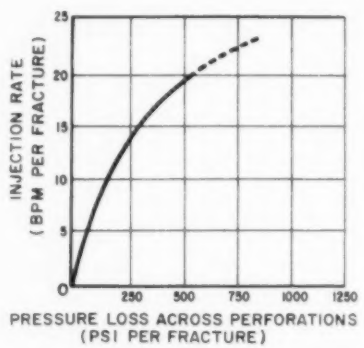

FIG. 2. **Injection rate vs pressure drop** across one set of perforations is plotted in this curve which represents an average of several field applications.

axially and laterally. This initial fracture may be readily extended by conventional hydraulic means without the usual pressure buildup encountered in hydraulic breakdown. The reduction in initial hydraulic pressure is illustrated in the tabulation of field data included in Table 1. Initial fluid injection is consistently accomplished well below the expected breakdown pressure.

The new method not only provides fracture plane control and positive breakdown of each zone but permits

It's not just a matter of SIZE

HALLIBURTON FRACTURING EQUIPMENT

..."Job" designed to point the way to a better payout".

Fracturing equipment designed for the job—large or small—provides better results with a minimum of time and expense.

Halliburton fracturing equipment is designed to handle all types of treating fluids, proportion additives into the fracturing medium and to perform under difficult pumping conditions.

Halliburton's larger variety of fracturing units, proportioners, special trucks and other equipment permits you to multiply fracturing power for your specific well's fracturing power requirements.

No matter what the needs of your well... pressure and volume capabilities for big or small jobs... in deep or shallow wells with high or low temperatures... you can choose the fracturing equipment best suited to give maximum production stimulation.

...and ask your Halliburton Fracturing Specialist for the valuable Halliburton book, "A Method For Fracturing Treatment Design"... the modern fracturing workbook filled with important and vital fracturing prescriptions to assist you in selecting the best method and equipment for your next job.

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FRACTURING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

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TWIN T-10 FRACTURING TRAILER

MODEL 45 SAND PROPORTIONER

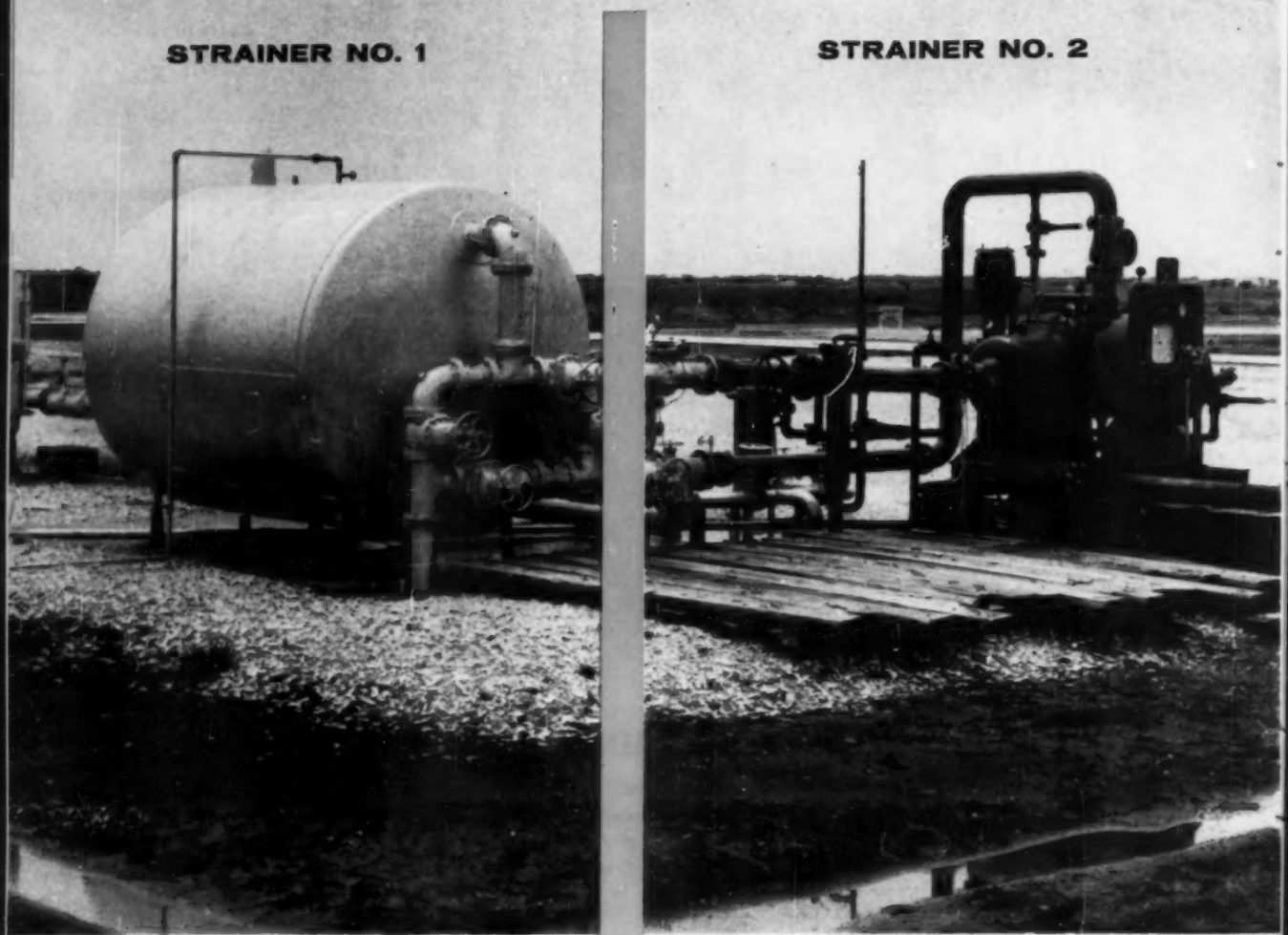
TWIN HT-400 FRACTURING TRAILER

MODEL 70 SAND PROPORTIONER

TWIN T-10 FRACTURING TRUCK

TWIN HT-400 FRACTURING TRUCK

MODEL 25 SAND PROPORTIONER



How much water can a strainer strain?

The answer is important in water-flooding

Strainer No. 1 is a conventional rapid sand filter. It is designed to filter *180* gals. of water per minute.

Strainer No. 2 is a Model 30-H. T-C Jet Strainer. It is designed to filter *450* gals. of water per minute.

The cost of the two strainers is approximately the same, considering the cost of auxiliary equipment required by the sand filter that is not needed with the Jet Strainer.

To clean the sand filter requires backwashing with filtered water. This takes time . . . costs money. The Jet Strainer can be cleaned in less than 5 minutes, requires no backwashing.

But the real pay-off is the difference in the filtering performance of the two types of strainers. The sand filter removes solids of a questionable minimum particle size . . . no algae or bacteria. The Jet Strainer can remove all solids down to 31-micron particle size with a bare screen. With a coating of filteraid on the screen the Jet Strainer removes all solids down to sub-micron particle size, including algae and bacteria!

Jet Strainer design lends itself ideally to full automatic operation, using any desired make of electronic controls.

Planning a water-flood? We will gladly send you complete details on T-C Jet Strainers.

T-C JET

Self Cleaning

STRAINERS

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Dualift MAST

and the DESERT RAMBLER....

constitute a major breakthrough in drilling rig mobility, for never before has drilling equipment of this capacity been made truly portable. THE DUALIFT—Ideco's latest drilling development and the largest trailer-mounted mast available — is capable of handling nearly 13,000' of 4½" drill pipe in trebles and hook loads of 310,000 pounds. The Dualift combines the time-proved principles of the Ideco Full-View and Kwik-Lift Masts for raising and telescoping to operating position. The DESERT RAMBLER—the largest completely wheel-mounted rig ever built—can be moved easily and quickly over very rough terrain and can be rigged up in a matter of hours.

GUYLESS... 127' CLEAR HEIGHT ...TREBLES

Crossover type crown — Flat side of traveling block faces derrickman.

Fabriform crown sheaves — Smooth operation and perfect balance at high speeds. Timken tapered roller bearings throughout.

Pipe racking capacity —
12,960' — 4½" drill pipe
16,200' — 3½" drill pipe

Telescopes in vertical position for faster, safer rig-up and lower raising stresses. Raising legs carry part of hook load and provide greater stability and wider weight distribution.

12' mast leg spread — Working floor measures 16' x 18' with catwalks.

Crown lifting device — Powered by truck winch—quickly levels mast trailer.

Heavy-duty "Desert Sand" tires available throughout. No ramps required for rig-up. Only two sledge-pin connections required to join mast trailer to drawworks trailer.

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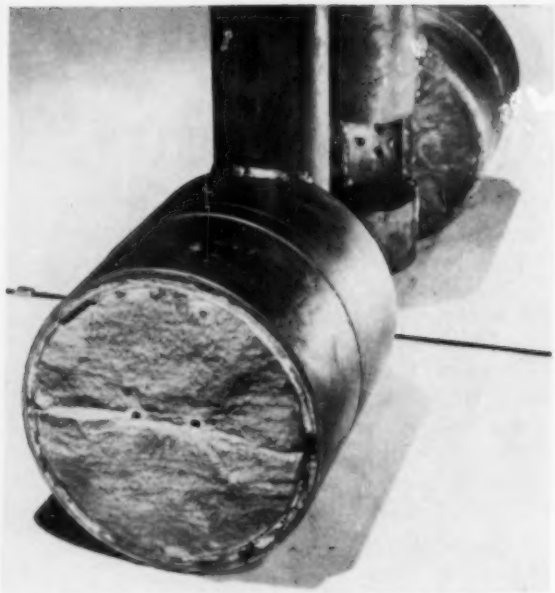


FIG. 3. **Berea sandstone target** shows fracture parallel to the bedding in this 10-in. diam core behind 4½-in. casing. Mirror shows entrance holes.

FIG. 4. **Target of Berea sandstone** illustrates fracture initiated across the bedding plane in this 10-in. core behind 4½-in. casing.

TABLE 1. Typical Field Results in Clinton Sand, Ohio
Approximate Depth — 3500 ft

Well designation	Operator	Number of fractures	Casing size —in.	Initial pressure —psi	Injection pressure —psi	Injection rate —bbl/min	Fracturing fluid
Clinage No. 1	Vanson Prod. Corp.	3	4½	1000	2200	45	Water-sand
Mykrantz No. 1	Marchant & Elmore	2	4½	2300	1800	38	Water-sand
Kiester No. 1	Yenne	4	5½	2000	2400	34	Oil-sand
Fetzer No. 1	Wehmeyer	3	4½	2300	2200	32	Water-sand
Hoenshil No. 1	Wehmeyer	2	4½	2000	1800	27	Water-sand
Jones No. 1	E. J. McBride	1	4½	1500	2800	30	Oil-sand
Fetzer No. 2	E. J. McBride	2	4½	2400	2100	28	Oil-sand
Brandt No. 1	Yenne	1	2½	2300	2900	10	Oil-sand

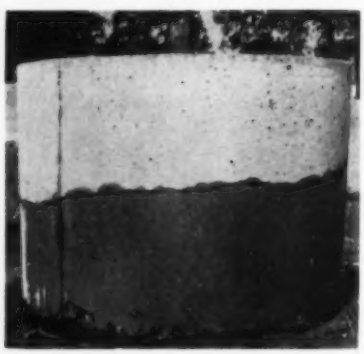


FIG. 5. **Horizontal fracture** in a 9-sack, 5-ft diam, fully cured concrete cylinder was extended to surface under hydraulic pressure of 1000 psi.

the use of less expensive casing. Isolation of zones for positive breakdown of all zones in multi-zone fracturing is not necessary. Since all zones are fractured before hydraulic injection into the well is begun, only slight crowding by injection rate is required. The hydraulic fracturing operation can easily be designed for a minimum of around ten bbl per min per fracture. At this rate, if not all fractures are taking fluid, sufficient back pressure will be developed due to the greater rate per fracture to cause extension of all fractures.

High injection rate capacity is indicated by the curve shown in Fig. 2. The pressure drop at an injection rate of 15 bbl per min per fracture is only 300 psi. Consistent results are attained through the use of a drag spring which maintains zero fluid gap between the tool and the casing wall. The spring is attached to a 5-ft long hollow sub which serves as a sinker bar as well as a shock absorber for protection of logging tools or collar locator which may be run in conjunction with the fracturing tool.

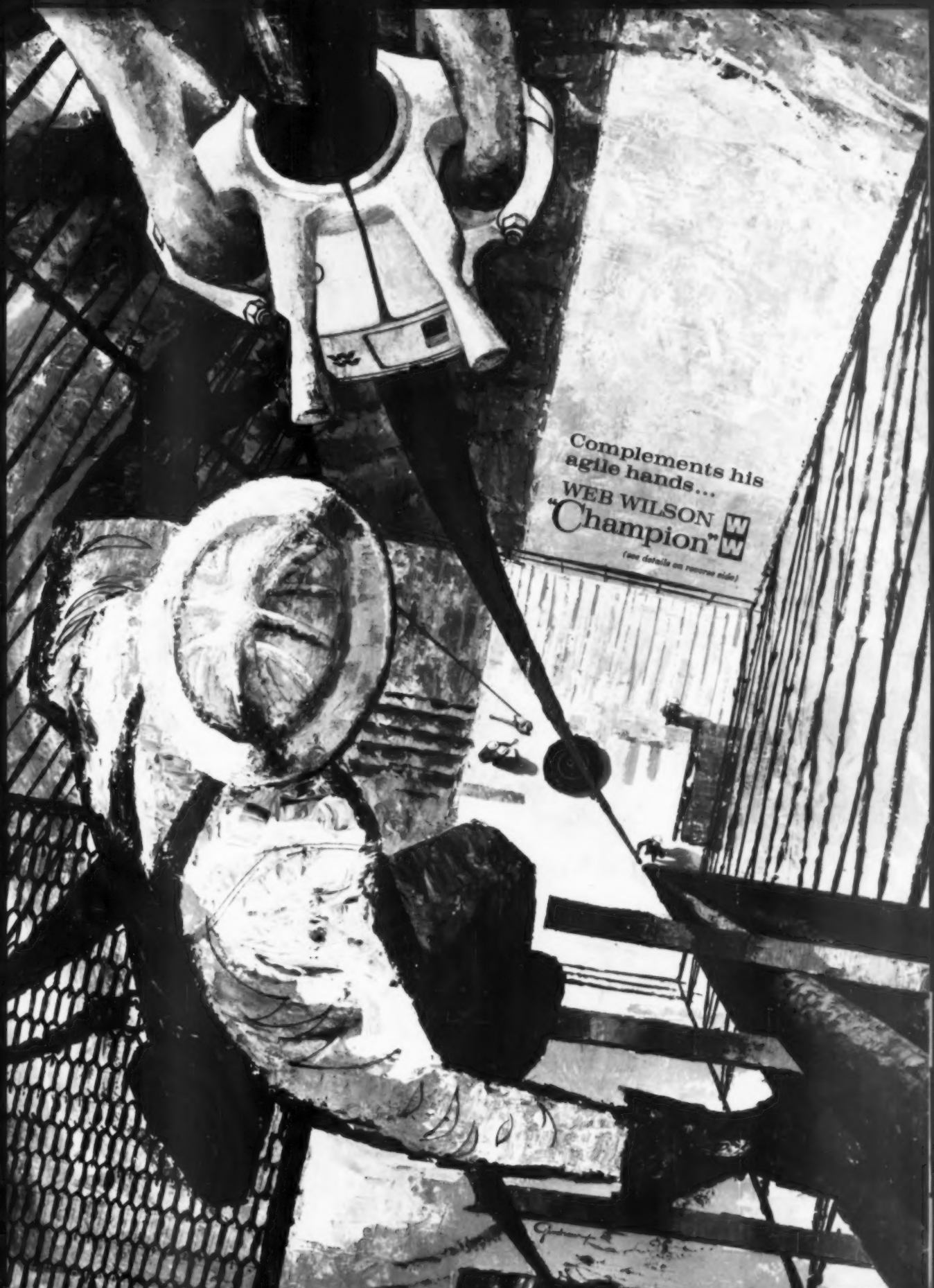
Berea Sandstone Targets

Fig. 3, 4, and 5 are photographs of various targets used in development and surface testing. Fig. 3 and 4 show the fracture parallel with the bedding and across the bedding in ten-inch diameter Berea sandstone cores. The targets were so constructed that the perforations extend through 4½-in. casing, ¾-in. cement, and into the sandstone core. After shooting, the targets were parted at a point 5 in. beyond the casing wall. It will be observed that the two parallel perforations extend through the fracture.

The target shown in Fig. 5 is 5-ft diam concrete cylinder through which a 4½-in. OD casing nipple was cemented. The target was cast of 9-sack concrete and fully cured. The resulting horizontal fracture was initiated by the fracturing process and extended to the surface of the cylinder by application of 1000 psi hydraulic pressure.

The new process is applicable in all areas where fracturing has proved beneficial as well as in many areas where active water drives or gas caps have made fracturing too hazardous. Also, large exposure through horizontal fractures in thin zones makes commercial wells where vertical fractures will not. This method may be used in the open hole or in perforated zones if the zone has not been previously fractured.

Oil Tool Engineering Corporation is not a service company but is engaged in the development and manufacture of oilfield tools and services. The new process is available through established wire line service companies. ★ ★ ★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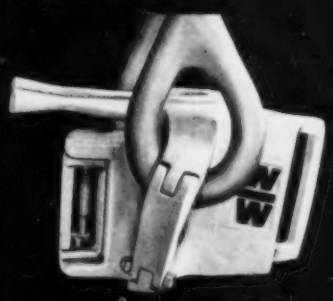
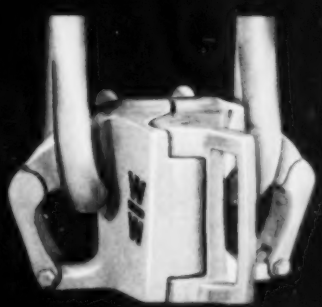
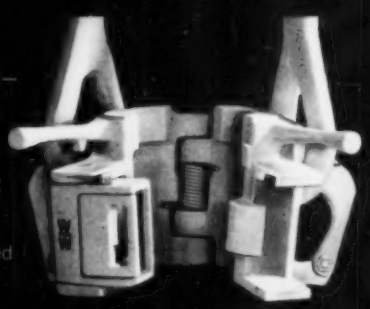
"CHAMPION" HAS SUPERIOR BALANCE, especially noticeable in the open position, that permits the elevator to roll and turn easier in the links. This is due to the unique swept forward link arms that provide greater freedom between the links and the elevator—yet, allow a more compact link-arm assembly.



"CHAMPION" HAS EASY-GRIP HANDLES for surer control. Detailed studies of crews as they ran drill pipe led to the development of several new handle shapes. These were thoroughly field tested to determine the most efficient design. "Champion" handles, thus chosen, gave crews more latitude in their work together with maximum safety.



"CHAMPION" LATCHING IS FULLY AUTOMATIC—the latch lock closes simultaneously with the latch, as the latch is applied to the pipe; and when the latch is released, a strong coil spring forces the elevator open and away from the pipe. Note: the built-in latch cannot be opened accidently and is protected from damage.



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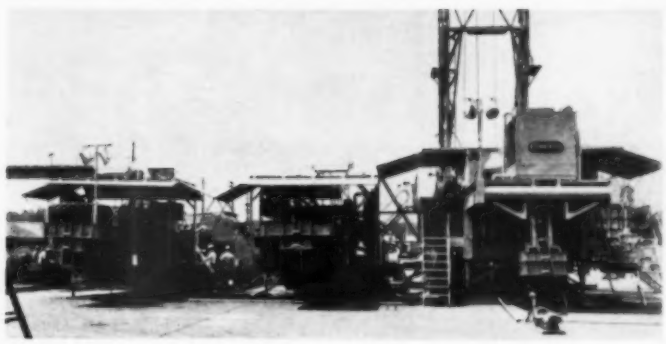

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PART 1

Technical Advances In Oil Well Drilling

Prelude to well completion course shows developments in drilling techniques from their origin to most advanced research

Otto Hammer, *Operating Vice President, Dresser Industries, Inc., Dallas, Texas*

A DISCUSSION of oil well drilling methods and future drilling requirements is essential to a study of modern well completion because certainly, completion techniques can well be determined by how we drill; where we drill; and how deep we drill.

Drilling an oil well is really a most peculiar business. It is the only business I know of where you start at the top and work your way down to the very bottom, in order to achieve success.

History has not recorded the time nor the place where the first wells were drilled, but we do know that the Chinese were among the first to drill wells

INTRODUCTION

EXECUTIVES of leading oil industry companies are assisting in the education of petroleum engineering students at the University of Texas through presentation of a lecture series on Modern Well Completion.

The oil industry expects institutions of higher learning to provide talented graduates with superior training that will enable them to assume positions of responsibility. It is thus appropriate that industry should cooperate with the faculties of engineering schools to help achieve this objective.

Since oil field service companies are engaged in most phases of well completion, experts in a particular field of activity for these companies will present a majority of the lectures during the academic year. These men have been specially selected by the management of their companies as being the best qualified to instruct students on their subject.

Each lecturer will relate how methods of well completion have been improved during their careers and predict improvements in the future.

For three of the lectures, the petroleum engineering faculty considered that the technical staffs of two major oil companies possessed some of the best knowledge and experience in the industry, and they secured lecturers from these companies.

The course is under the direction of Dr. George H. Fancher, head of the Department of Petroleum Engineering.

Dr. Paul D. Torrey, university special lecturer and seminar organizer, has conducted much of the planning and arrangements for the course.

All of the 16 lectures presented in the course will be featured exclusively in *The Petroleum Engineer,* and the first two appear in this issue.

These lectures will appear in future months:

Conditioning Mud for Well Completion
Robert W. Ruhe, Jr., Magnet Cove Barium Corporation

Electric Logging of Wells
W. P. Biggs, Schlumberger Well Surveying Corporation

Electric Log Interpretation (at the well)
R. P. Alger, Schlumberger Well Surveying Corporation

Radioactivity Logging of Wells
John G. Stick, Jr., Lane-Wells Company

Turbodrill
J. A. Mitchell, Dresser Industries

Radioactive Log Interpretation (at the well)
John C. Wilson, Lane-Wells Company

Drill Stem Tests
Cecil R. Richardson, Halliburton Oil Well Cementing Company

Design of Casing Strings and Running Casing
J. F. Hendrickson, Phillips Petroleum Company

Cementing Practices
Phil Montgomery and Dwight Smith, Halliburton Oil Well Cementing Company

Perforating Casing
F. O. Bohn, Lane-Wells Company

Formation Fracturing
W. E. Hassebrook and C. D. Saunders, Halliburton Oil Well Cementing Company

Chemical Treatment and Well Stimulation
Francis N. Harris, Halliburton Oil Well Cementing Company

Multiple Zone and Permanent Type Completions
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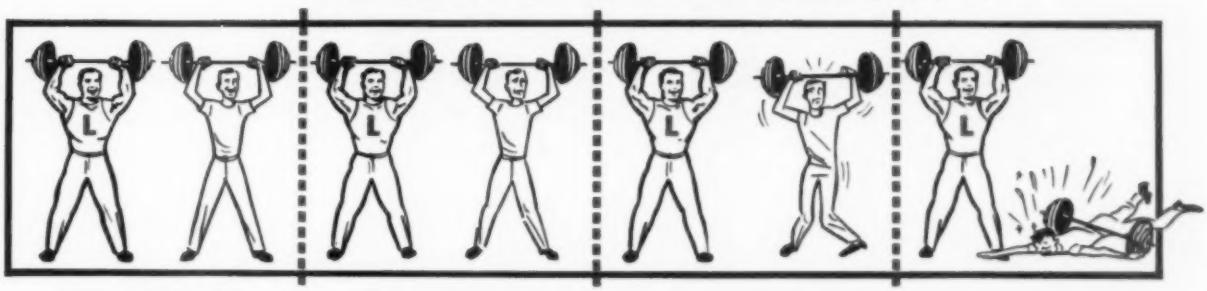

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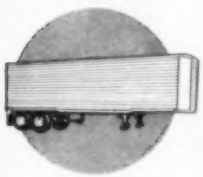

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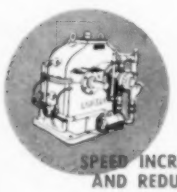

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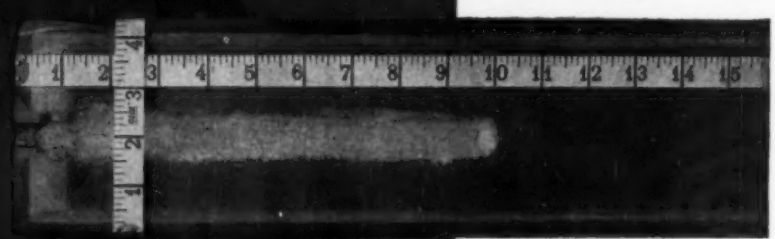

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by mechanical methods and for industrial purposes. Over 10,000 of these early wells were drilled below 1500 ft — not for oil — but for the production of brine to manufacture salt, which was an exceptionally good commodity of trade at that time.

These early Chinese drillers used a system similar to that which we identify as cable-tool or churn drilling. Practically all of the equipment used — the cable, the casing, and the derrick — was made of bamboo. The power, of course, was man power.

The equipment used to drill the first recorded well in the United States was very simple. The well was drilled for brine in 1806, near Charleston, West Virginia, and the method used was the forerunner of our present day cable-tool system.

This early drilling method employed a spring pole, about 20 ft long, set in the crotch of a forked piece of timber with one end tied to the ground. A drilling cable was fastened to the free end of the pole, and a small diameter crude iron bit attached to the cable. Stirrups were located at the pole's free end.

The advent of rotary drilling occurred in the historic Spindletop oil field near Beaumont, Texas, in 1901. Again, this early equipment was crude as measured by today's standards, but it marked the beginning of advances in designs and techniques employed in the rotary system—the drilling method which is now used extensively throughout the world wherever oil is produced.

Drilling equipment produced during this period was made of plain carbon steel in its various grades and forms — largely because it was the only type of steel economically available and in the tonnages required.

In fact, when I first started in this business in 1926, many oil tools, whose functions were vital, were made of discarded railway car axles and old oil well drawworks. It is difficult to imagine producing an important functional part today from "junk-yard" steel with many years of service behind it, and most likely in a severe state of fatigue.

Metallurgy was virtually unknown in the drilling industry, and the utilization of heat treatment was not practiced. As can be expected, failures were numerous.

Deeper drilling caused increasingly severe operating conditions which soon taxed the capacity of the best carbon steel equipment and revealed the definite limitations of this material. These new operating conditions demanded higher strength steels capable of being used satisfactorily in lighter sections. The engineers, and the few metallurgists in the oil industry at that time, turned to alloy steels which were better suited for these severe conditions.

It did not take long to learn that special heat treatment procedures were necessary to obtain better performance from steel selected for the job. This led to a wave of experimental work which resulted in establishing a general category of alloy steels for a specific oil field use.

As time went on, some of these steels fell by the wayside, and new ones were added in the ever increasing search for better performance of the finished product.

In 1859, Colonel Drake, using a

Dr. Paul D. Torrey

DR. PAUL D. TORREY, organizer of the course on Well Completion Practices, was appointed distinguished lecturer at the University of Texas in 1956. He has had a long and outstanding career in the petroleum industry.

Dr. Torrey graduated from the University of Pittsburgh in 1925 with the degree of BS in petroleum geology, and in 1927 he received the degree of Petroleum Engineer at that university. He later received the degree of ScD in petroleum engineering from Marietta College in 1952.

Upon graduation he worked for the Petroleum Branch of the United States Geological Survey in the Rocky Mountain States, in Arkansas, and in Pennsylvania. He became petroleum geologist for Northwestern Pennsylvania Oil Producers Association, and for approximately eight years he worked in the oil fields of Pennsylvania and New York for the association and as a consultant. During this period he undertook geologic studies which resulted in the discovery of important deep gas reserves in New York and Pennsylvania.

In 1935, Dr. Torrey became chief engineer for the Sloan and Zook Company in Texas, and subsequently as a consulting engineer and executive officer of several oil and service companies. He undertook the business of what is now Orchem Corporation in 1951 to specialize in the development of chemical processes to improve the recovery of oil.

Achievements during his career include founding the first commercial laboratory for the analysis of cores from oil reservoir rocks, and establishing positively for the first time the presence of interstitial water in oil reservoirs; making an engineering study of the secondary possibilities of the shallow Bartlesville sand fields of northeastern Oklahoma in 1932-33, the results of which have been used widely in the secondary development of the Nowata field; and at the end of World War II supervising similar studies in Ward and Winkler counties, Texas which resulted in the first systematic waterflooding operations in West Texas.

During his career he has compiled 63 technical papers dealing with various phases of petroleum geology and petroleum engineering. These include contributions to the United Nations Scientific Conference on Conservation and Utilization of Resources, and the Third World Petroleum Congress.

Active in industry affairs, Dr. Torrey has served as chairman of the Eastern District and Southwestern District Topical Committee on Production Practice; as chairman of the Central Committee on Drilling and Production Practice; and as chairman of the Standing Subcommittee on Secondary Recovery methods of the American Petroleum Institute.

He was the first API officer to receive the Institute's Certificate of Appreciation for engineering studies. At present he is serving as chairman of the Secondary Recovery and Pressure Maintenance Committee of the Interstate Oil Compact Commission.

Dr. Torrey is a registered professional engineer in Pennsylvania and Texas. He is a member of the American Petroleum Institute, the American Institute of Mining and Metallurgical Engineers, the American Association of Petroleum Geologists, the American Geographical Society, the Society of American Military Engineers, the Society of the Sigma Xi, and Sigma Gamma Epsilon.

He is now a petroleum advisor to industry specializing in secondary recovery.

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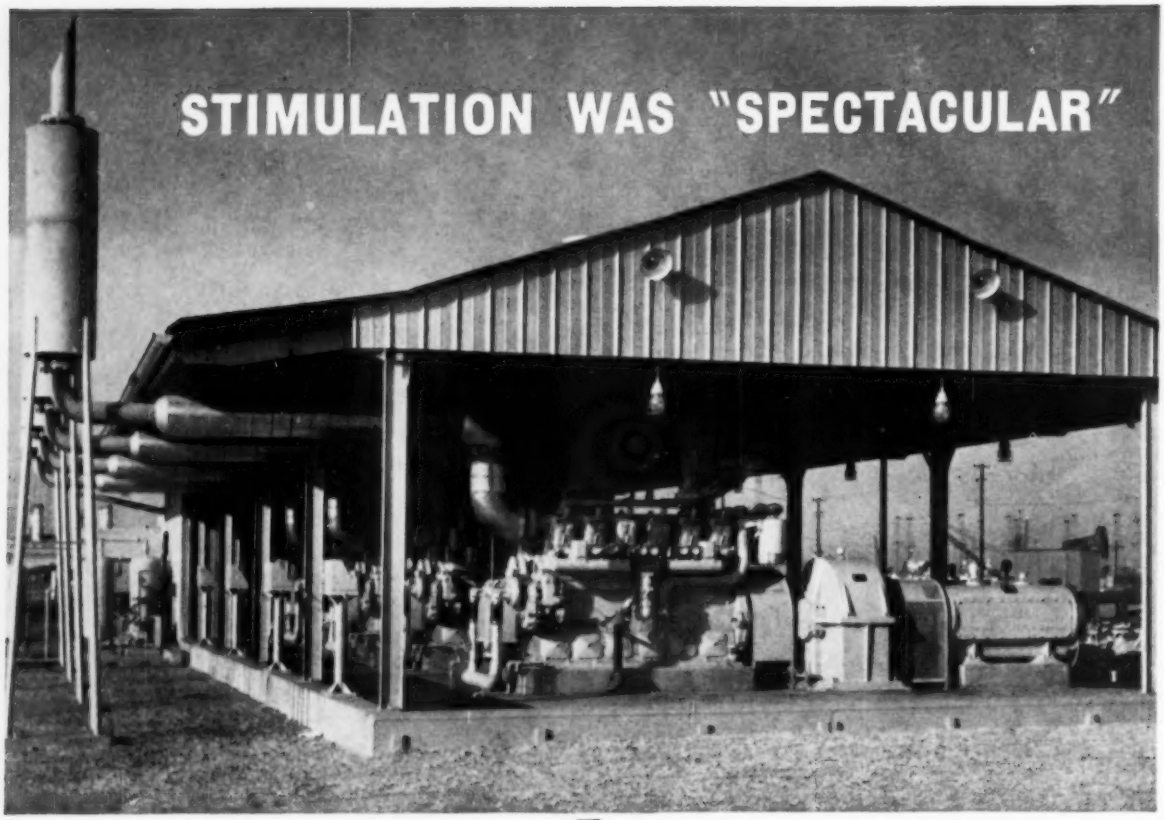

waterflooding at Long Beach with WAUKESHAS

The waterflood repressuring project—under Long Beach City property, in the Wilmington California Oil Field—is probably the country's largest. The Waukesha-Engine-powered Pier E station is the project's second water injection plant. Ten months after its activation, stimulation observed was "spectacular" as one expert put it.

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The four Waukeshas are Model VLROB natural gas engines, 12-cylinder, 8½ x 8½-inch bore and stroke, 5788 cu. in. displ. Engines are set to max. full load speed of 1020 rpm to give approx. pump speed of 175 rpm driving through speed reducers with 5.857:1 ratio.

These Waukesha Engines are equipped with S-69 Western Gear speed reducers; Ross 1204-CP Heat Exchangers; couplings—engine to reduction gears, 28-CB-525 Fawick—gears to pump, Fasts No. 6.

Send for Waukesha Bulletin 1656.

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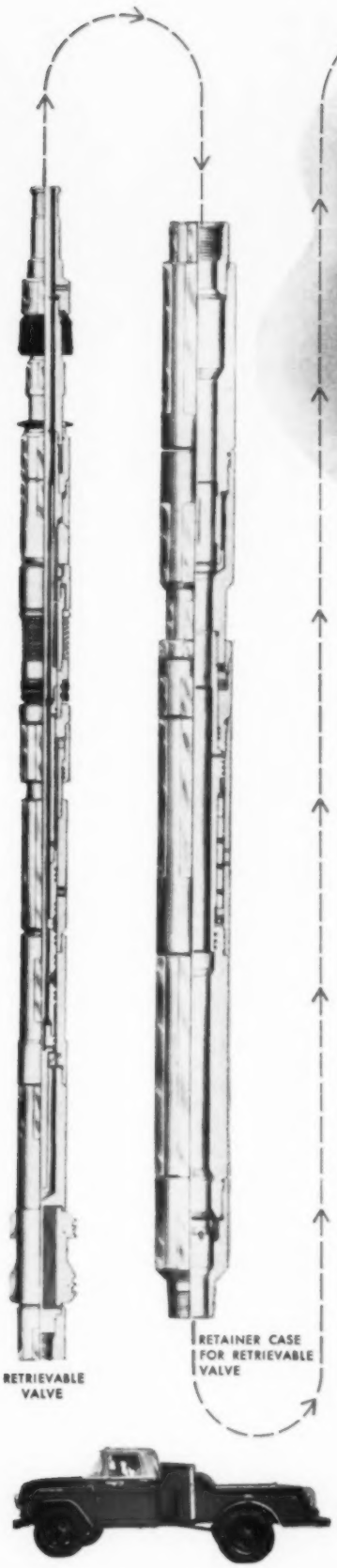

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HALLIBURTON RETRIEVABLE VALVE TESTER

Developed for use with Halliburton Retrievable Test-Treat-Squeeze (RTTS) Packer for a formation test to permit subsequent operations of treating, squeezing, perforating or further testing ... *with only one trip into the hole!*

The Retrievable Valve Tester is composed of two basic assemblies – The Retrievable Valve, for opening and closing positions for formation testing – The Retainer Case, to provide a seat for the Retrievable Valve.

Retainer Case is run in tubing above "RTTS" Packer and is an integral part of tubing string during all operations. Valve is operated by right hand tubing rotation when set in Retainer Case. Setting blocks lock the Valve in the Case preventing Valve from being forced up tubing from pressure below. Valve is released from Case by a 5-position sliding valve which is set in close position; and is removed by wire line or reversed circulation after test; leaving full opening through tubing string.

A pressure recorder attached to Valve and locked in place in Retainer Case before going in hole offers many operational benefits:

- Formation testing with complete closed-in-pressure
- Allows removal of Valve and pressure recording device to check bottom hole pressure ... without unseating packer
- Permits a continuous flow test
- Application of stimulation treatment
- Downhole operations can be repeated on multiple zones ... *with only one trip into hole*

RUNNING CASE WITH STRAINER FOR PRESSURE RECORDING GAUGE...

Serves as a protective case for running Pressure Recording Gauge with Retrievable Valve Tester. Attached to lower end of Valve, permits removal of Gauge with Valve for examination of pressure chart recordings immediately after test is completed.

For *better* well services—*routine or special*—Halliburton provides "SPECIAL TOOLS FOR SPECIAL JOBS"... call your local or district Halliburton Representative today for Special Tool Services whenever or wherever the need occurs.

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SPECIAL TOOLS SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

"284 SERVICE CENTERS—JUST MINUTES AWAY FROM YOUR WELL"

makeshift rig, consumed more than three months to drill a hole 69 ft into the ground. In the ensuing 100 years, wells drilled to 15,000 ft in the same length of time are common occurrences and the record depth stands at 25,340 ft.

The striking difference in drilling rates is wholly due to the technological advances made by all phases of the drilling industry — the operators, the drilling contractors, and the petroleum equipment manufacturers, suppliers and service companies.

Perhaps the drilling rig is the most conspicuously improved piece of oil well equipment in the field today.

By 1890, the cable-tool rig had developed into a fairly respectable piece of equipment for the times. These rigs were of wooden construction with the parts nailed together to form the structure. The wooden rig was to endure, without much basic change in its pattern, through the advent of rotary drilling and on through the 1920's.

By the mid 1920's, however, a division of our company introduced the new concept of fabricated steel derricks, the chief advantage of which lay in their capacity to handle far heavier loads of drill pipe. These first steel rigs were of the permanent type and usually remained in place after the well had been completed. They are still to be seen today in profusion in such places as Beaumont and in California's Signal Hill field.

Exactly 20 years ago this month, this division developed another new concept in drilling rigs which constituted a revolutionary change in basic rig design and soon swept the entire industry.

This was the idea of the portable rotary rig. Advances in the automobile industry made it feasible to build a truck powerful enough to haul a piece of equipment weighing upward of 50 tons. Since this type of drilling rig utilized the drawworks to lift the mast into drilling position, it could be moved easily and rigged up in a fraction of the time required for the standard derrick. Many modifications came along, but all of them incorporated the same basic idea of utilizing the drawworks to lift the mast into drilling position.

Today's masts, utilizing cantilevers, telescoping principles, and dual-purpose power devices, represent a great degree of sophistication over the standard four-legged wooden rigs of the 1920's and the steel derrick of the 1930's. As late as 1933, drilling rigs were equipped with 84-ft derricks and 200 hp operated the drawworks and turned the rotary tables. Now it is common for rotary rigs to tower 146 ft into the air and operate with as much as 3000 hp.

The story of drill pipe is also one of continuous improvement to meet the demands of a growing industry.

When Colonel Drake drilled his 69 ft well he used a wooden conductor pipe and cast iron drill pipe with the joints held together by wrought iron bands. After completing the well, Drake ran a string of 2½ in. brass tubing to produce the oil. Faced with the great drilling depths that are common today, the driller would find all of Colonel Drake's methods completely unusable, even for starting a hole.

Only a decade after Colonel Drake's well, the comparatively fragile cast iron pipe had already been supplanted by wrought iron drill pipe.

In the course of time low-carbon, lap-weld steel drill pipe — the same as used for pipelines — supplanted wrought iron pipe. With the advent of deeper drilling, this lap-weld pipe showed several weaknesses such as breaking at the threads, twisting in two, and bursting at the seams under pressure. In the early 1920's seamless drill pipe first appeared and ended most of these failures. Today, with the addition of alloying metals and manufacturing refinements, drill pipe does a yoeman's job.

A good part of the credit for the high efficiency achieved by the drilling industry can be attributed to improvements made in drilling bits over the years.

The first rotary bits were of rather simple design, having two cutting edges formed on a single blade. These bits were known as fish-tail bits because of the resemblance of the cutting edge to a fish's tail. From those simple cutting tools, a series of drag bit designs evolved with three or four or more blades arranged in the shank to produce an untold variety of cutting patterns. These bits had no rotating parts and were inefficient in the harder formations encountered as well depths increased.

In the middle 1920's, roller rock bits, which were originally designed for drilling the harder formations, were going through a slow but sure period of evolution from relatively crude devices to the highly efficient rock cutting tools in use today.

The introduction of anti-friction bearings, specialized cutting tooth patterns for drilling different types of formations, and jet circulation nozzles — coupled with the ingenuity of the designers and metallurgists in the rock bit business — has resulted in a rock cutting tool which allows the driller to produce in an hour or so the same amount of hole that took Colonel Drake more than three months to drill.

Shortly after World War II, diamond oil well bits were used in the Rangely, Colorado, oil field when formations were encountered which were difficult to drill economically with rock bits.

These bits consist of a specialized pattern of commercial diamonds securely mounted in a hard matrix. As the bit rotates, the diamonds scrape away at the formation. Diamond bits are used primarily in formations that are uniform in structure, hard and compact.

Another important advance in drilling practices is in the drilling mud used in the circulation system.

During the 1920's, several people advanced the idea that material heavier than native mud might help in preventing blowouts. The first attempt used iron oxide in the circulating fluid. Soon after, barite was discovered to be a good weight material, and bentonite was used shortly after to serve as a sealing agent.

Nowadays, the science of adding the right weight or volume of material to the circulating fluid is a very complex one, involving collaboration between geologists, chemists, and petroleum engineers. Most mud companies have a whole catalog of mud additives, some simple, some chemically complex, which are designed for specific uses in almost every case where a well problem exists. As wells go deeper, the demands for mud treatment grow ever more exacting, and there are now several special muds available for hot wells when encountering high formation temperatures.

With the myriad of technical improvements introduced into the drilling industry over a relatively short period of time, the petroleum industry is constantly seeking new techniques and new devices which will drill holes faster, better, cheaper and deeper.

To this end, oil producers, drilling contractors, and equipment manufacturers in the United States and abroad are concentrating on and experimenting with new drilling methods. Some of these are modern adaptations of old ideas, and others are somewhat of a radical departure.

Innovations such as air drilling, substituting air or gas for the drilling mud, and slim hole drilling, using smaller, conventional equipment and tools to do the job, are two approaches toward reducing drilling costs. They are finding increased use in the oil fields.

Turbodrilling, percussion drilling and electro-drilling are revised versions of old ideas whereas sonic drilling, high velocity flame drilling, explosion drilling, and drilling by means of electric discharges are some of the newer approaches to the problem.

The interesting thing to note about all of these newer drilling devices is that the power which actuates the bit

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BAROID'S *basic additive for* **OIL-BASE-** *emulsion drilling muds*

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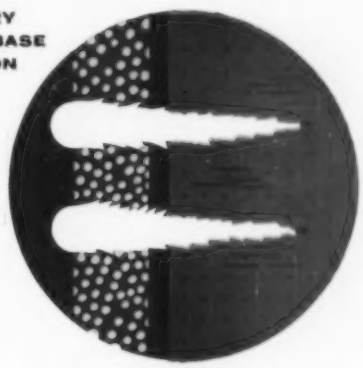
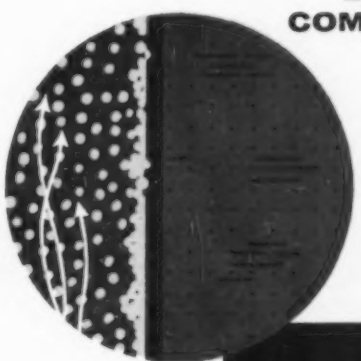


BETTER COMPLETIONS

INVERMUL . . . stabilizes oil-base-emulsion mud prepared with crude or refined oils.

INVERMUL MUD . . . protects formations against water damage.

INVERMUL MUD . . . is easy to maintain or recondition during drilling, coring or working-over.



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or cuts the hole is located at the bottom of the bore hole.

Turbodrills are drilling engines located at the bottom of the well directly above the drilling bit, and are operated by the same fluid that is pumped down the drill pipe in rotary drilling. With turbodrilling, the pipe which extends from the turbodrill at the bottom of the hole to the surface of the well becomes merely a conduit for transmitting fluid under pressure to the turbine drilling engine. This fluid flows through the vanes of the turbine and turns a shaft which drives the cutting bit. Useful horsepower developed at the bottom of the hole ranges from 300 to 450, all of which can be applied directly to the cutting bit, since none of this power is wasted in rotating thousands of feet of drill pipe.

Our company has been conducting planned turbodrill development programs for the past two and one-half years. During this time, refinements and innovations have been incorporated into the tool until now it is considered to be a powerful down-hole engine that is suitable for oil field use and operates in a trouble free manner.

So far, the principle obstacle in the way of economical turbodrilling is the inability of the bits to withstand the turbodrill's high speed and horsepower characteristics. The bits simply wear out too fast. This requires the bits to be replaced more frequently and thereby offsets economical gains made by the turbodrill's greater penetration rate, which averages from 2½ to 4 times that of conventional rotary.

Intensive work is now being done on this bit problem, and it is hoped that the answer will be forthcoming in the not too distant future.

Rotary percussion drilling is fundamentally a combination of the hammer-blow action used in the cable-tool method and the rotating motion of the rotary system. It is somewhat similar to the action of a pneumatic tool used in construction work.

Air or liquid pumped through the drill pipe actuates a hammer in the percussion tool, which is located above the bit. The downward blow of the hammer, combined with the conventional rotation of the bit, is designed to increase the bit penetration rate several times that of rotary alone.

Electrodrills are exactly what their name implies — long, slim, electric motors, usually of the three-phase alternating current design, located at the bottom of the well to drive the bit.

Power is supplied to the motor by one of two methods. The first is through an electric cable running from the surface to the motor, with fluid circulation effected by means of a centrifugal pump mounted on the motor shaft. Bit cuttings are gathered in a chamber in the unit and periodically lifted to the surface. The other method provides an electric cable mounted in the drill pipe with special tool joint connections installed to create a continuous feeder line to the motor.

In sonic drilling, sonic or acoustic waves are generated in a down-hole device by utilizing the circulation flow through the drill pipe to rotate a high speed turbine which in turn rotates eccentrically weighted disks. The sonic waves generated are in the range of 30 to 50 cycles per second and impart a high frequency vibratory action to the bit while it is rotated.

In the more exotic areas of drilling methods research, high velocity flame drilling is used to some extent for shallow shot holes in mining operations. Drilling to depths required by the oil industry presents several problems, such as fluid pressure environments, drill pipe with multiple passages and complex connections, and the ever-present problem of removing the waste material from the well bore.

Shortly after World War II, the United States Bureau of Mines conducted experiments on explosion drilling, which consists of disintegrating the rock and making the hole by means of subsurface blasting with special shaped-charge explosives. After many tests, the project was abandoned because the cost was found to be over 20 times that of producing a hole with a rock drill.

Recently, the Soviets have announced that they are experimenting with this system and have developed a method of circulating the charges to the bottom of the hole in a continuous stream. This is an interesting approach to explosive drilling, provided the cost of the explosive is not prohibitive.

The electric discharge method of rock destruction is based upon the effect which takes place when the fluid-filled space between two electrodes is broken through by high-voltage electrical discharge. Shock waves are generated in the fluid and their reaction on the rock causes its disintegration.

The Soviets are also experimenting with this approach to producing a well bore, but the method appears to be quite inefficient in its present state of development.

Which of these ideas will provide the break through the economic barriers remains to be seen. But one thing we do know—in time, wells will be drilled faster and deeper because they need to be drilled faster and deeper.

Today, the record well depth is 25,340 ft, and geologists are of the opinion that oil bearing sedimentary rock deposits exist in certain areas as deep as 30,000 ft or perhaps deeper.

As wells are drilled deeper, problems multiply. Many accepted practices and equipment used today will have to be discarded or changed materially to provide for the increased demands on the rig hoisting equipment, the drill pipe, and casing strings. Higher pressures and temperatures, expected at greater depths, can well require different cementing materials and techniques as well as create a whole new series of mud problems. Hole temperatures can exceed the draw temperatures of rock bit components, whereby they would lose their hardness and attendant ability to attack the formations.

Now, it is quite possible that some of these problems might confront us sooner than we think.

As recently as August of this year, the U. S. National Academy of Sciences declared their intention to drill a hole through the earth's crust into the Moho layer. This is a transitional boundary between the earth's crust and the mantle which overlies the earth's core and where the velocity of seismic waves suddenly increases.

Preliminary surveys have been made for possible drilling sites at opposite sides of the continent. A site near Guadalupe Island in the Pacific, and another off the coast of Puerto Rico in the Atlantic are under consideration. At these locations, the ocean depths are between 10 and 18,000 ft and to reach the Moho will require drilling through a possible additional 14 to 25,000 ft of the earth's crust.

Can you imagine a derrick and rig mounted on a vessel and keeping it plumb at all times during storms as well as calms? Attempting to stabilize a string of casing against the currents in the water between the vessel and the bottom of the sea, and then drilling an additional 14 to 25,000 ft through the earth's crust?

Feasibility studies are now being conducted, and it is expected that the project will be well under way within the next few years.

At present, there is no complete rig capable of handling equipment to drill a hole to this combined depth, and drill pipe and casing factors certainly present problems. But with the best of drilling and equipment technology, it is believed that the job can be done.

The fact alone, that this daring venture is feasible, is a distinct tribute to the technological advances achieved by every phase of the petroleum industry.

At this point, project Mohole is still in the formulative stage, but when the hole is drilled, a scientific achievement will be accomplished every bit as spectacular as orbiting a satellite around the earth. ★ ★ ★

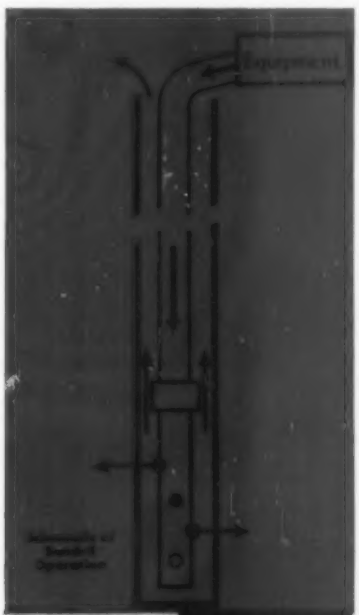
NOW—A REVOLUTIONARY APPLICATION OF HYDRAULIC POWER

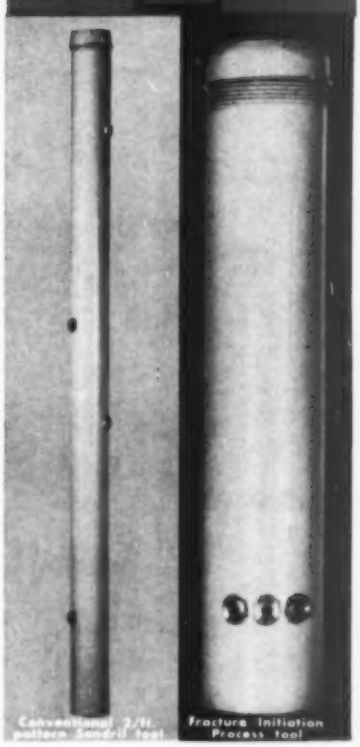
WESTERN'S SANDRIL PROCESS

Versatile new method of—

- ★ Controlled penetration in casing perforating
- ★ Controlled penetration in open-hole perforating
- ★ Shoot and treat on same set-up
- ★ Shoot and test on same set-up
- ★ Assured penetration through contaminated zone
- ★ Permanent completion
- ★ Natural completion with no treatment
- ★ Any application requiring deep penetration into matrix

Sandril process utilizes a special tool run into the hole on the end of the tubing string. A sand-fluid mixture is then pumped down the tubing, through orifices in the tool and jetted against the casing and/or formation. Penetration is controlled by pumping time.





CONTROLLED PENETRATION — Extreme penetration of **SANDRIL** process is demonstrated in this four-foot square limestone block. Sand-laden fluid stream penetrated casing, cement and 20 inches of limestone during five minute pumping period.

Wells throughout the Southwest have been perforated with Sandril conventional spiral pattern and Fracture Initiation pattern in conjunction with fracturing treatments and also as separate natural completions.

Application has varied in depth up to 11,000 feet, in both open hole and cased wells. Sandril tools in three sizes — 1¼" O.D., 2" O.D. and 2½" O.D. — have all been utilized.

In all cases, effective, **CONTROLLED** penetration — measured in feet instead of inches — has been attained.

Get all the details on **SANDRIL** — how it will give controlled penetration in your well — from Western service points throughout the Southwest. Call your Western Engineer.

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MODERN WELL COMPLETION SERIES

PART 2

Improvements in Well Completion Practices

Oil well cementing . . . drillstem testing . . . chemical services . . . and hydraulic fracturing are analyzed to show their contribution in successful completions

L. B. Meaders
President
Halliburton Oil Well Cementing Company
Duncan, Oklahoma

'KNOW HOW' in drilling wells to extreme depths has been very successful in the past few years. Since 1955, approximately 500 wells have been drilled below 15,000 ft, while prior to 1950, this depth was seldom exceeded. Progress in oil well cementing has kept pace with the industry in the engineering advancements of deep well drilling.

Oil Well Cementing

It is foreseeable that wells will ultimately be drilled to 40,000 or 50,000 ft in search for oil bearing formations. Mechanically speaking, we now have pumping and service equipment capable of cementing wells considerably beyond the record depth of 25,000 ft recently established by the Phillips Petroleum Company in West Texas. Research in cementing materials and retarders also leads us to believe that wells can be cemented successfully at temperatures and pressures that would be anticipated at 50,000 ft depths.

While these extreme conditions represent a challenge, there have also been many problems and accomplishments in cementing practices at shallow and moderate depths.

Considering the materials used today, more than half of all the cements pumped in wells contain some type of additive. Actually, in addition to the basic manufactured cements, over 30 special additives are available to change oil well cements for specific applications.

The use of pozzolans blended with manufactured cements has provided more durable as well as functional compositions for cementing wells at all depths. At elevated temperatures, the utilization of pozzolan-lime reactions makes the tailoring of cements for longer pumpability much easier. These compositions have also been found to be more stable than regular cements at high temperatures.

Low water loss materials, gilsonite, accelerators, heavy weight additives, latex, resins and special grouting chemicals represent some of the other materials that have achieved wide usage in the field of oil well cementing.

Recent mechanical advancements include the following: (1) More efficient cementing plugs, (2) Automatic fill-up floating equipment, (3) Improved centralizers and scratchers, (4) Automatic weighing and slurry control devices on pumping equipment represent progress in the field of automation.

Permanent well completions, slim hole completions, concentric pipe workover and tubingless completion, are examples of the industry's efforts toward reducing operational cost in producing oil.

With such changes in completion techniques, additional materials and mechanical modifications will naturally result.

Drillstem Testing

Research and development have produced many changes that render drillstem testing a vitally needed service to the industry. Only a few years back, the results of drillstem tests were determined by the fluid or gas recovery. The addition of a subsurface pressure recording device to determine whether or not the testing valve was open proved of such importance that through the improvement of the device, greater accuracy in pressure recording was provided. It was then found that pressure points recorded on the chart could be used to determine the future of the zone, of the well, and even of the area in which the well was located. Today, the numerous pressure points of the recorded pressures on drillstem tests play an important part in the final completion of producing wells.

Because the normal temperature gradient is not effective in all areas and in all zones, subsurface temperature recording devices have come to play a large part in many services prior to well completion. This will become more important as wells are drilled to greater depths and bottom-hole temperatures increase.

The retrievable valve tester; multiple-zone wire line tester; the hydraulic packer; the hydrospring tester; expanding shoe packers; and improved rubber compounds that lend to greater strength yet maintain resiliency for increased sealing effects, both in open hole and in casing packers, are recent developments that play new parts in drillstem testing.

Special tools required for production, treating, and remedial services have been designed to cope with modern drilling procedures. New packers now provide multiple-purpose tools which may be used for varied services without removal from the well.

Permanent and retrievable bridge plugs reduce rig delay and provide economy in service operations.

Chemical Services

Acidizing has a 30 year history, but only in recent years has there been a measurable change in techniques of application, or variation in the types of acid used.

Hydrochloric acid is still basically

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PILOT-OPERATED VALVES

MERLA

Merla intermitting gas lift valves can be tailored for efficient lift of your well. These pilot-operated valves can take advantage of spread to store gas required for lift in casing annulus. Control of casing pressure determines size of fluid slug and GOR. Snap-closing action is needed to control an intermitting well with surface choke or to fluid-trip with a pressure controlled valve.

These three Merla snap-action gas lift valves provide you the means for a dependable, trouble-free installation.

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WF-3

For conventional mounting on tubing mandrel, the WF-3 features a large gas port. Extra guards provided for dual completions.

WFM-3

For small clearances, the slender WFM-3. This valve may be mounted on special mocassin mandrels for running inside tubing.

WF10R

This wire-line retrievable valve features full opening port.

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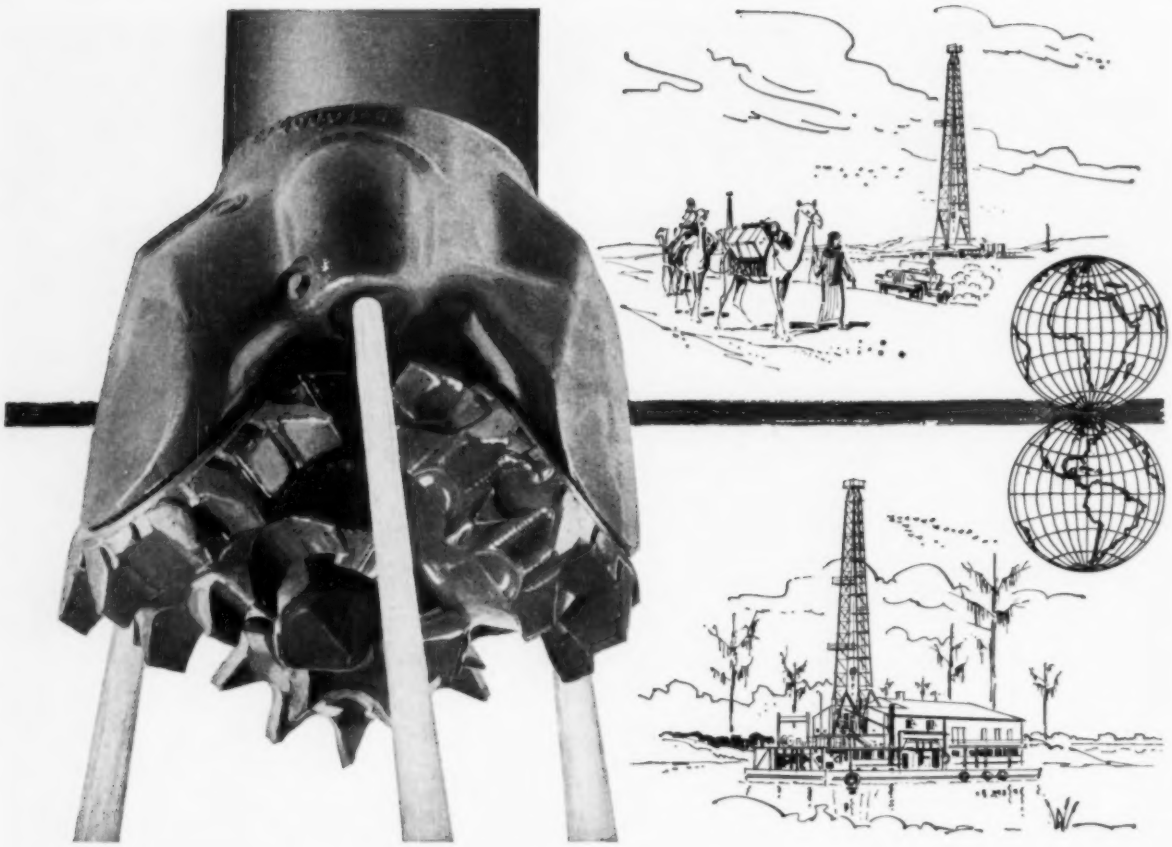

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Security's S3J jet bit, pictured above, cuts drilling costs equally well in Libya and in the Texas-Louisiana Gulf Coast. Other Security jets set similarly outstanding penetration records in Venezuela and the Rocky Mountains.

All are constructed to the same superior design specifications, metallurgical values, and quality control standards. That's why Security is right around the world! . . . the *right bit for the job* wherever in the world you drill.

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with C-E equipment . . engineered for economy

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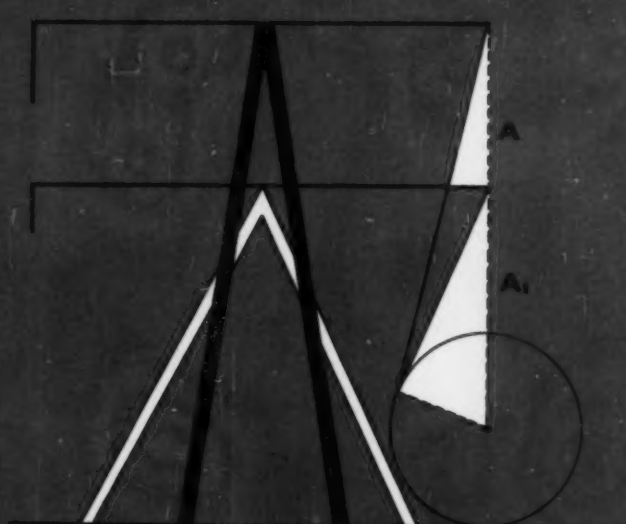
New design cuts power costs . . increases counterbalance efficiency . . provides more flexibility in meeting well conditions and prime mover applications . . lowers maintenance time and cost

NOW

CONTINENTAL-EMSCO UNIT PUMPERS are ENGINEERED even better.. NOT JUST BUILT!

Angle A has been decreased with taller samson posts over angle A_1. This improved geometric design makes well loads more nearly equal at wrist pin and polished rod for more efficiency, less wear.



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NEW, BOLT-ON-TYPE WRIST PIN DESIGN
Speeds-up stroke changes. Just run in two bolts, tighten them up and housing halves are joined accurately . . easily.

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Provides superior lubrication for all bearings . . makes maintenance inspection easier. Time-proven C-E features remain.

SAFE, EASY ONE-MAN COUNTERBALANCING
Can be adjusted for leading or lagging load points . . no screw or bolt arrangement to rust-up and freeze.

HERE'S HOW L.06 LOAD MULTIPLICATION FACTOR IN EVERY C-E UNIT PUMPER SAVES YOU MONEY

C-E's superior L.06 load multiplication factor is gained by improved geometric design . . primarily by taller samson posts. Angle "A" in sketch shows how well loads are more nearly equal at wrist pin and polished rod. This means: (1) less wear on gear teeth and bearings; (2) lower power costs due to easier starting . . less peak loads; (3) more effective application of counterbalance weights . . often eliminating the cost of additional weights. API torque factor charts are available on request.

FLEXIBILITY THROUGH 18 SIZES

A choice of 18 different C-E Unit Pumpers makes it easy to match well conditions with the right torque capacity, structural load and stroke length. You purchase the *right* size unit. Too large a unit wastes capital and results in costly underload and excessive power costs. Overloading, primary cause of premature failure, is no longer necessary, either. Prime mover mountings are available for all types of power applications. Wide base units, universal center tie-down, hinged horseheads and dual pumping carrier bar are available on order.

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with Continental

SUCKER RODS

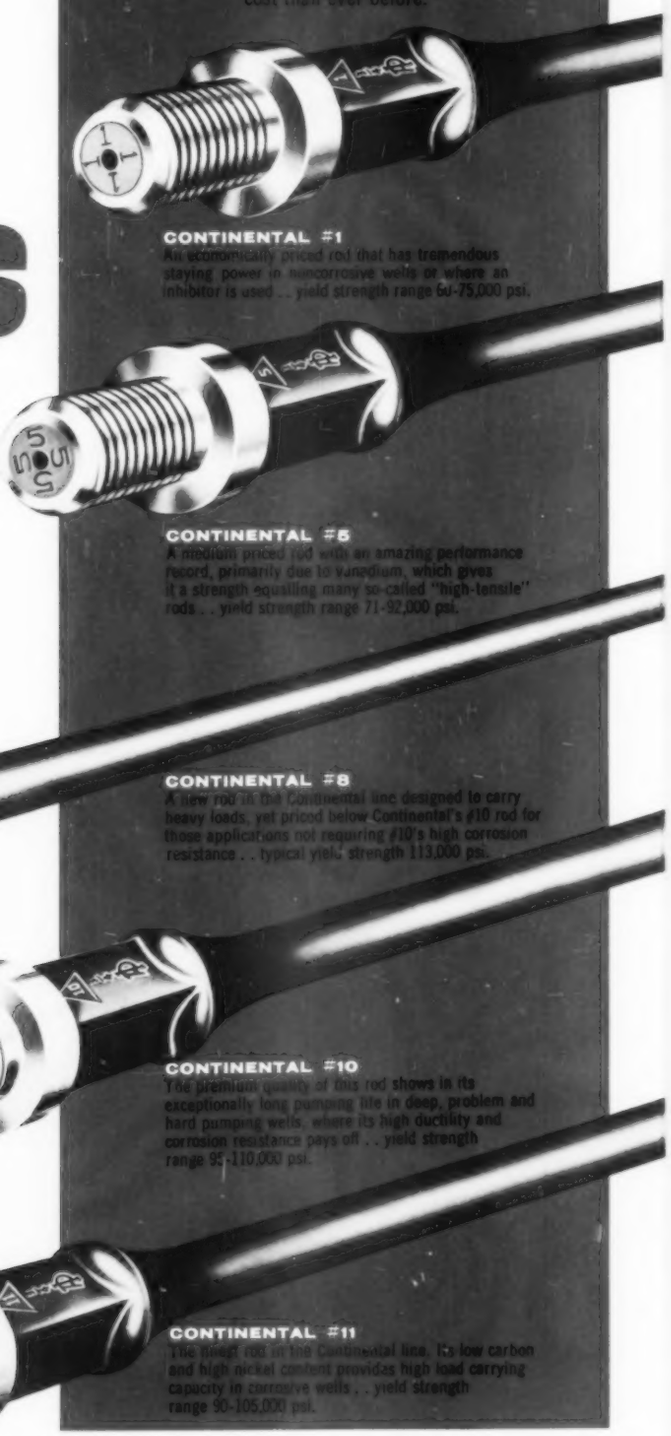
CUT EXCESSIVE, ..COSTLY PULLING JOBS!

Ask your Continenta

with the right Continental sucker rod for a

now 5 grades

To meet each well condition at a lower maintenance cost than ever before.



CONTINENTAL #1
An economically priced rod that has tremendous staying power in noncorrosive wells or where an inhibitor is used . . yield strength range 60-75,000 psi.

CONTINENTAL #5
A medium priced rod with an amazing performance record, primarily due to vanadium, which gives it a strength equalling many so-called "high-tensile" rods . . yield strength range 71-92,000 psi.

CONTINENTAL #8
A new rod in the Continental line designed to carry heavy loads, yet priced below Continental's #10 rod for those applications not requiring #10's high corrosion resistance . . typical yield strength 113,000 psi.

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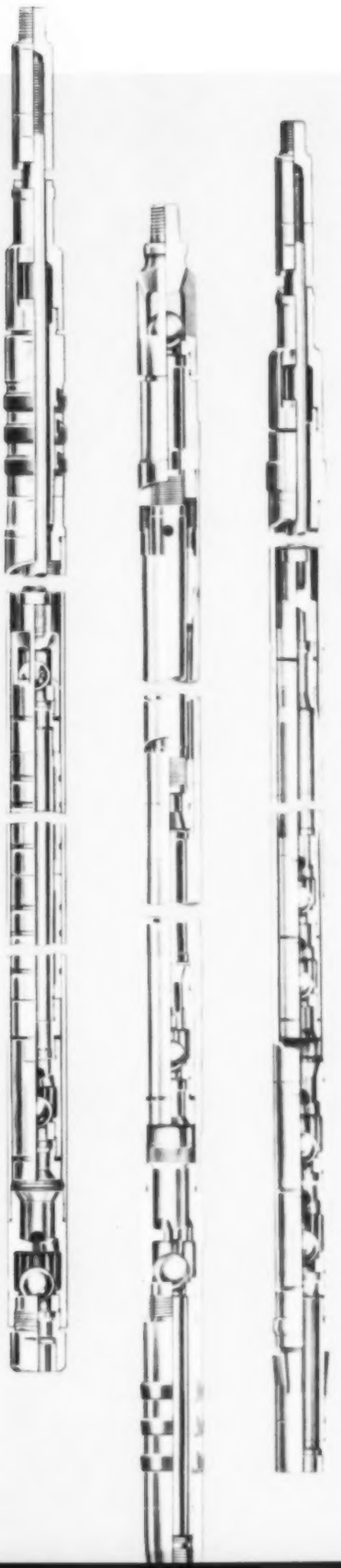
The premium quality of this rod shows in its exceptionally long pumping life in deep, problem and hard pumping wells, where its high ductility and corrosion resistance pays off . . yield strength range 95-110,000 psi.

CONTINENTAL #11
The finest rod in the Continental line. Its low carbon and high nickel content provides high load carrying capacity in corrosive wells . . yield strength range 90-105,000 psi.

ental-Emsco representative to fit your well
for a string that pumps longer!



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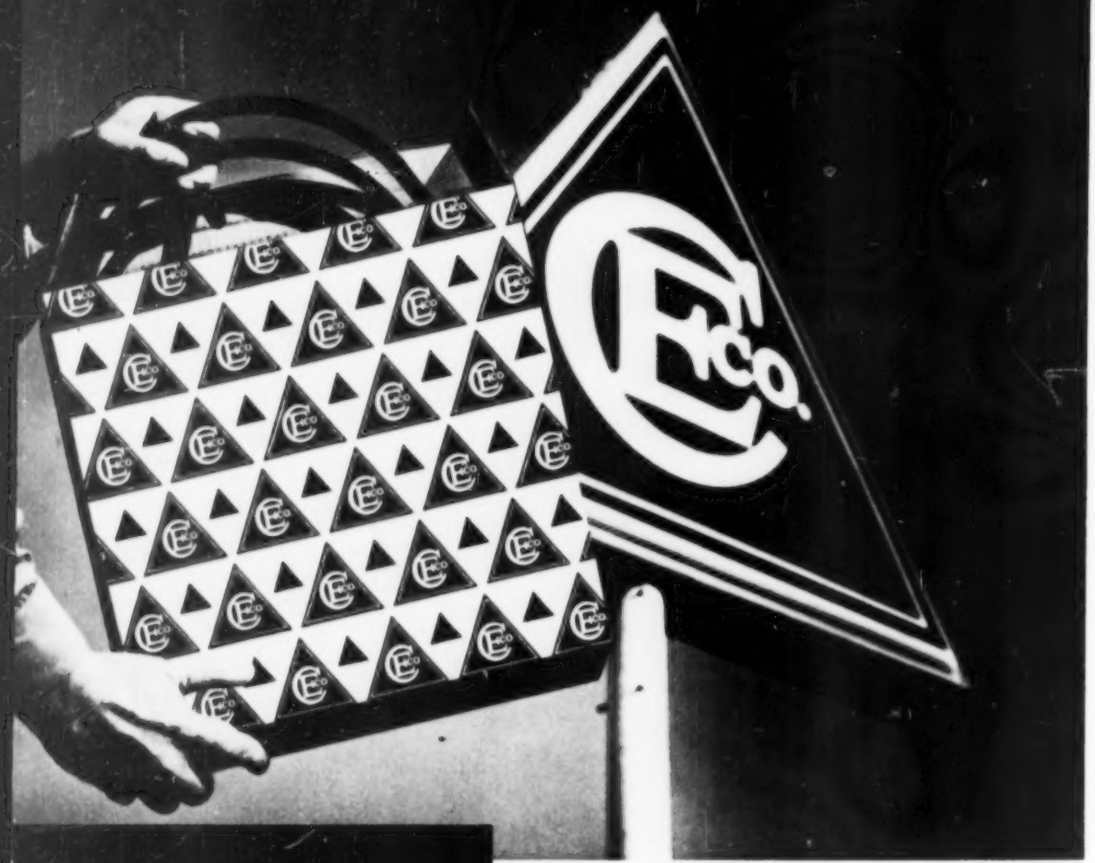
700 Types and Variations . . One to Pump Every Fluid Condition: Oil, Gas, Sand, Corrosion . . Every Deep, Shallow, Crooked or Straight Hole. Where does your problem in bottom hole pumping lie? . . sand cutting pump parts? . . gas locking? . . corrosion eating up barrel tubes? You name it . . there's a D+B pump to solve it. And at low cost, too. Strictly API, D+B pump parts are interchangeable. This means special pumps are made with *standard* parts. This is true even in two-zone installations, where standard API pumps are used for both the upper and lower zones. Through D+B engineering a great reduction has been made in the use of special parts for special pumps. So, cut those costly . . unnecessary . . special parts inventories. Start *pumping more profits* the proven, high-quality D+B way. D+B pump shops located conveniently near your lease provide the highest quality in parts and service for *all* subsurface pumps.



PUMP MORE PROFITS

with C-E prime movers designed exclusively for oil field pumping

C-E GREEN TRIANGLE ELECTRIC MOTORS

These C-E Green Triangle Electric Motor features cut your production costs: (1) Built-in balance meter simplifies counterbalancing and shows visually when the well is in balance. This results in less wear on all well equipment . . less downtime . . less repair and pulling costs; (2) Operational features include high slip, high starting torque, 55° C rise, class B insulation with a *guaranteed* 1.15 service factor. These features contribute to less stress and strain on well equipment. Peak power demands are reduced, cutting electrical costs; (3) Installation requires less time

C-E Green

due to mo
size condu
of weathe
New Gree
Motors a
phase mo
available
area, thes
three pha
inventory
single pha

C-E ENGINES

What "powerhouses" these engines are! Pumping away through hot, cold, wet or dry climates throughout the world. Always easy to start . . easy to adjust . . easy to service . . easy to repair, they are the most dependable item on your lease. If you are not pumping with C-E Engines, *you just don't have all the facts.* Find out about them today from your C-E store or representative. Using C-E Engines on your wells is a good way to *pump more profits.*

C-E Green Triangle Electric Motors and C-E Engines . . First Prime Movers Designed Exclusively for Oil Field Pumping Service.

PUMP MORE PROFITS

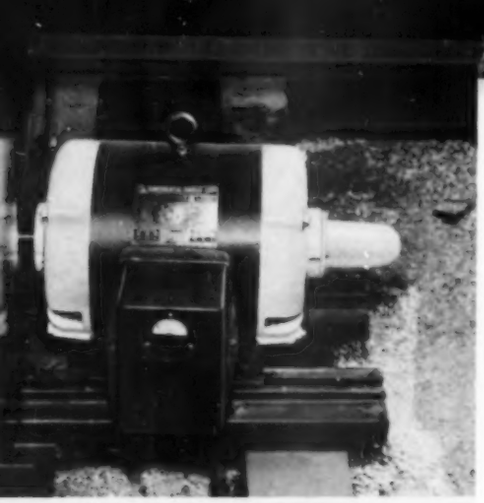
MATCHED SETS guarantee uniform high quality, grade, size, diameter, strength and freshness.

with New Green Triangle

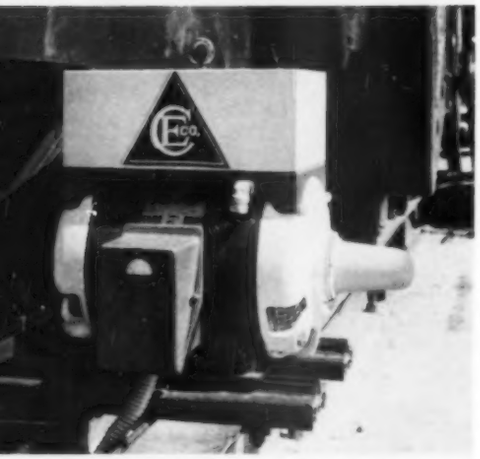
SUPER V-BELTS

40% More Capacity . . No Increase in Price

Modern manufacturing processes now build 40% more capacity into C-E Green Triangle Super V-Belts with no price increase. New molding technique forms new-type fabrics into a unitized cover for longer operational life. Each fiber in the cord is impregnated with latex, not merely surface coated. Cords are built into the belt under tension to insure uniform loading on each one. There are no inner or outer joints or laps to accelerate wear or cause vibration. Stretch has been reduced to cut field adjustment, while flexibility has been increased making it easier to bend belt over small sheaves.



Standard C-E Green Triangle Motor



Green Triangle Single Phase Motor, convertible to three phase

motor's double shaft extensions and over-
onduit box. Motors can operate in all types
eather because of splash-proof enclosures.
Green Triangle single phase "Convertible"
rs are lower in cost than ordinary single
motors. When three phase power becomes
able or motors are moved to a three phase
these motors can be easily converted for
phase operation in the field. This cuts
tory costs and the "junking" of unuseable
phase motors.

PUMP MORE PROFITS

..with dependable service
from Continental-Emsco

Whenever . . wherever you need service you can depend upon Continental-Emsco men to bring you an intimate knowledge of your production problems and a way to solve them. This is not left to chance or localized experience, rather a continuous, company sponsored, comprehensive training program keeps Continental-Emsco men *fully informed*. They are ready, willing and able to provide the latest in equipment . . recommend new pumping techniques. They are backed by 76 strategically located D+B pump repair shops, properly equipped to service and renew your pumps. Let your Continental-Emsco man show you the Continental-Emsco way to more profits through reduced maintenance, replacement costs and capital investment.

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Serving the Oil and Gas Industries ... Worldwide

P922

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NOTHING excels this unit for

AUTOMATIC PRESSURE CONTROL WHILE DRILLING!

THE SHAFFER ROTATING BLOW-OUT PREVENTER AND STRIPPER

has no equal in modern pressure control protection because no other equipment is so versatile... so simple... *so dependable!*

It *automatically* seals off around the drill string when the tools are in the well. You can run drill collars, tool joints, subs and drill pipe through it—going in or coming out—and *the Stripper Rubber maintains its pressure-tight seal throughout all drilling and pipe-changing operations.* Pressure emergencies simply cannot happen too fast for this unit. It is always sealed off until the drill string is removed from the well.

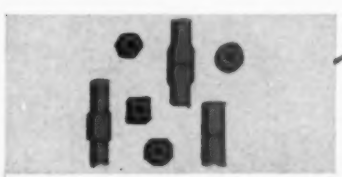
Check over the important features outlined below. You'll find the Shaffer Rotating Blowout Preventer and Stripper ideal for every important drilling requirement!

WEAR-FREE!

The Stripper Rubber rotates with the kelly—not one inside the other. Therefore, flexing and wear are negligible as the drill string rotates. Note that separate thrust and radial bearings (each pre-packed with heat-resisting lubricant) resist any combination of bearing loads!

SIMPLE!

To pass bits, reamers and other abnormally-large diameter tools through the unit, simply lower the tools through the body until the rotating assembly seats in place. Then rotate the bonnet 1/6 turn. This locks the entire internal mechanism in place, to provide a continuous seal against well pressures.



VERSATILE!

All the varying diameters in the drilling string—drill collars, tool joints, subs and drill pipe (whether upset, flush or coupled)—readily pass through the Stripper Rubber without loss of pressure—and without any manual adjustments. Even the kelly—whether square, hexagon or octagon—is sealed off *automatically!*

CONTINUOUS!

The Stripper Rubber expands and contracts automatically to fit all normal elements in the drill string (excepting only bits, reamers and similar large diameter tools). No hydraulic, pneumatic or mechanical pressure need be applied. No accessory equipment is required!

COMPACT!

Unit is amazingly compact in all dimensions—can be installed in unusually "tight" locations. Even flow connections are built-in—no space-wasting spools are required!

TROUBLE-FREE!

A barrier of flexible steel latches protects the Stripper Rubber against damage while varying diameters pass through the unit. This expandable steel barrier also protects the rubber from extrusion under high well pressures!

TWO TYPES—Use the Type 50 for drilling through 10¾" casing and larger... Use the Type 51 for slim hole drilling, production and rework jobs. Both have the same basic features!

For further details see your nearest Shaffer representative, or write direct!

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EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

the main constituent in acidizing because it is the most efficient and economical acid available for permeability improvement.

Today, however, modified acids are prepared in advance of any anticipated difficulty. They include: Emulsion prevention, low surface tension, retarded reaction, thickened acids for temporary blocks, mud removal solutions, and acid mixtures to prevent secondary deposition of solids after chemical reaction on the formation ceases.

Surfactants, a coined word taken from surface active agents, has a much shorter history than acid for well completion and production improvement. Originally, they were used in conjunction with only acid. However, more recently they have been blended with other solvents.

In the future, as dictated by present trends, the use of chemicals in well completion practices and production improvement will continue to grow rapidly. This is understandable because of the intensified research programs that are under way within the industry.

Normally chemical treatments, where applicable, will add only a small percentage to the total cost of putting a producing well on the line. It is also an economical approach for workover operations. In these days of proration, economics becomes an all important factor.

Hydraulic Fracturing

Approximately 275,000 fracturing treatments have been performed since the commercial introduction of hydraulic fracturing in March 1949. Treatments range from 1000 gal of fluid to in excess of 500,000 gal. Of the estimated 37 billion bbl reserves in the United States and Canada at the end of 1958, at least 10 percent or 3.7 billion bbl have resulted directly from hydraulic fracturing.

The Pembina field in Canada, for example, can probably be attributed entirely to chemical services and fracturing. Approximately six dry holes were drilled and abandoned. One company attempted to complete a well by setting pipe and perforating, which resulted in a dry test. An acid surfactant treatment was performed after which the well tested about 300 bbl per day. A fracture treatment was performed resulting in a potential of about 600 bbl per day. Today, approximately 2500 wells are producing in the Pembina field, most of which required fracturing to become commercial producers.

Recent advancements and trends in this important well service include better completions which adequately prepare the well for fracturing; a wide variety of fluids, each having properties more satisfactory for specific formation and well conditions; specially designed additives available to improve the properties of the fluids giving much more flexibility to each; and controlled perforating.

What of the future of fracturing? More theoretical and mathematical approaches should change this service from an art based on experience to more of a science. Here are goals to improve results through research:

1. Complete predesign of treatment both chemically and mechanically.
2. Better understanding of fracture geometry and extent on which production increases are dependent.
3. Be able to determine post treatment production prior to treatment.
4. Better utilization of equipment and materials.
5. Improved instrumentation to give better control of treatment during job.
6. Increased knowledge of mechanics of maintaining the fracture open with better propping agents.
7. Materials and techniques for satisfactory production stimulation of very deep wells. ★ ★ ★

NEW from Skinner Brothers to Meet Industry Demands!

First Hydraulic Oil Saver with Manual Takeover

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U-65

has what you need in a . . .

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For dual or triple completions, the O-C-T U-65 Tubing Hanger has no peer in the number of advantages offered—in mechanics, economy and safety. This component part of the O-C-T Universal Tubing Head allows all strings of tubing to be raised simultaneously at completion.

But, other advantages are major. Check them:

- Simple, direct setting procedure
- Need for sleeve valves eliminated
- Completion is with tree in place
- Flange connections can be field-tested
- Complete range of sizes, working pressures

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A Year of Progress in AOSC

In a year characterized by 'hard knocks' for the petroleum industry, the Association of Oilwell Servicing Contractors has recorded a year of growth and progress

J. C. Williams, Jr.
President, Association of Oilwell Servicing Contractors

BY AND LARGE, all facets of the oil industry have had very good reason to consider 1959 as "the year of the locust." Subject to congressional attacks, the steel strike, low producing allowables in various states, and a seeming revulsion of public opinion against the industry, oil has nevertheless fought back, and strengthened its position.

Oil well servicing, as represented by the members of the Association of Oilwell Servicing Contractors, has, of course, been as always, extremely sensitive to each of these changes, and has with the rest of the industry, struck hard to increase its prestige and take its place as an aggressive forward-looking branch of the industry.

In retrospect, it is difficult to express the feeling of pride in the work AOSC has accomplished in the past year without seeming personally vainglorious. At the same time, any progress that has been made has been accomplished only through the united efforts of all the officers and directors of our association, and has been at least partially successful in achieving certain needed projects only because these dedicated men have given of their time, their effort, their money, and their foresight.

Unity and Cooperation

I personally believe that our greatest accomplishment as an association during 1959 has been to achieve an awareness among our membership, both large and small, that unity, not only of oil well servicing people, but of all members of the oil industry, is the survival factor of the future. Increased government taxation, both state and federal, against oil and oil products has made the profit factor of the oil industry nearly disappear. Large oil imports, increased labor and material costs (for oil exploration in particular) and increased buyer resistance (leading to a resistance to passing on these increased costs to the consumer) has leveled off any "boom tendency."

The profit line has been held by producers in the past year only by reducing the cost of producing oil. Sound business methods and a greater awareness and analysis of producing costs have been made by the oil industry. We, as well servicing contractors have been faced with the problem of cooperating with the producers to help keep their cost down. It has been necessary for our association to prove factually to producers that the well servicing contractor long ago felt the pinch and had reduced their profits before 1959. This has resulted in a realization of the need of unity and cooperation between us and our producer-customers.

Unity and cooperation must be the theme of the oil industry in the future. The AOSC has shown its eagerness to help in every way possible by actively taking part in the depletion fight of 1959, and is actively watching for any other congressional threats to oil as they may arise.

Another example of our association's desire to keep the oil industry well and happy has been an aggressive drive against any further extension of the morally and legally regrettable "kickback," whereby the producer is not permitted a fair day's work for a fair fee because the producers own employees may have a *sub rosa* financial arrangement with the well servicing contractor doing his work. The abolition of this practice is practically a holy crusade by our association, and is a war which we will continue to fight.

Growth of Membership

Of course, we would like to point out that the AOSC has grown territorily during the year 1959, with the addition of a strong chapter in the Tristates, and the acquisition of several members in California.

The problems of the individual contractor have not been forgotten in the past year. Using the purchasing power of the group as a whole, we have been able to shop for an insurance market with various companies, and have adopted a program covering general insurance which may well be the answer to many insurance problems presently affecting our contractors. Results for present participants in the association-provided program have been in some cases quite dramatic. Other contractors have felt the program did not exactly fit their needs, but it is our feeling that by and large the very dark insurance picture of the past few years has become much lighter during the past 12 months.

We do not pretend that the efforts of the association on behalf of its membership will create a brave new world for the association members or for the oil industry. We do, however, know that the day of the rugged individualist bulling his way over all obstacles by sheer force of character is nearly over. This is the age of the trade association. The unity provided by this association has and will without question improve the overall conditions of individual contractors and, in one small way, may help the oil industry in its overall battle for survival. ★ ★ ★

MR. JOE ZEPPA

President,
Delta Drilling Company

President,
American Association of
Oilwell Drilling Contractors

"Initiative, ingenuity and inventive skill."

"Modern drilling programs continue to become more demanding. Deeper wells, higher pressures and temperatures require the Drilling Contractor to have the finest equipment, top-notch crews and, above all, the know-how to drill a good well economically.

"Progress in oil and gas well drilling would have been much slower without a healthy, competitive contracting industry.

"The Drilling Contractors' feverish search for improvement, coupled with today's technological and equipment advances, make it possible to get the job done faster, under more difficult conditions, with a greater amount of success and at a lower cost per foot.

"Much of the credit for this can be given the equipment and service industries whose continual research and development programs have offered solutions to many of the complex drilling and production problems.

"As a Drilling Contractor, in a highly competitive business, I can attest to the many advances made in our industry. This progress is the result of initiative, ingenuity and inventive skill so typical of the manufacturing, supply and service companies serving us today."

P.E.S.A.*

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PROUD TO BE PART OF A PIONEERING INDUSTRY

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

"Saves space... costs less, too"

W-K-M Cross-Type Multiple Completion Valves feature through-conduit gate construction, Teflon seat inserts for Double Tight sealing, pressure seal bonnets, superfinished stems supported on roller bearings, seating surfaces sealed from the lading flow. They can be overhauled on the line.

Sizes: 1¾" and 2"

Working Pressures: 2000, 3000 and 5000 pounds.

PRODUCT OF W-K-M's *Creative Engineering*

W-K-M® Cross-Type Multiple Completion Valves

These compact new valves simplify tree construction. They cost less than conventional tree components, yet provide all the outstanding features found in W-K-M's world-renowned oilfield gate valves.

W-K-M integral cross-type valves are available for dual and triple completions.

Next time — and every time — specify W-K-M! *At leading supply stores everywhere.*

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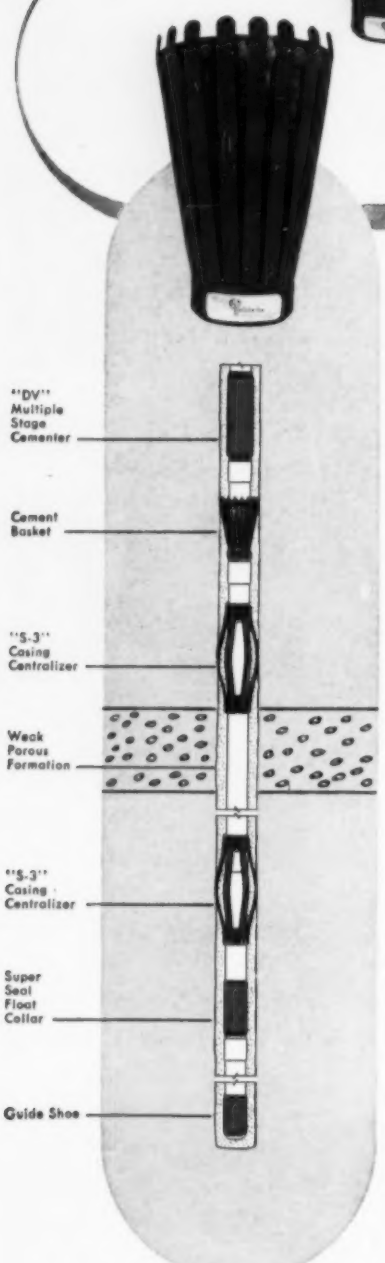
FOR THOSE WEAK, POROUS FORMATIONS...

HALLIBURTON CEMENT BASKETS



OPERATIONAL DIAGRAM
FOR CEMENT BASKET
AND OTHER HALLIBURTON CASING PRODUCTS

Rugged, easy to use and economical... that makes this cementing tool important for porous or weak formations.

The Halliburton Cement Basket is especially designed to provide a dependable annular bridge that will reduce fluid loss or break down of weak formations, and help support the cement slurry column until its initial set.

The Halliburton Cement Basket is expertly constructed of high strength flexible steel staves, mounted on a steel ring that slips over casing and an insert liner of heavy duty water-proof canvas that is riveted to the staves and ring. The insert liner is resistant to oil, weak acids and mud chemicals.

The steel staves permit fluids to by-pass upward while running casing, circulating or cementing. After the casing becomes stationary, or circulation is stopped, the basket expands to the bore wall like an inverted umbrella. Any downward movment of fluids or solids against the basket firmly presses the staves and insert liner close to the wall to form an effective annular bridge.

Halliburton Basket Casing sizes are available from 4½" to 10¾", covering minimum through maximum hole sizes from 6¾" through 16¼" inclusively.

FOR IMPROVED CEMENTING RESULTS USE HALLIBURTON CEMENT BASKETS...

★ on casing below a Halliburton "DV" Multiple Stage Cementer to retain cement and aid in protecting weak formations by reducing the hazard of slurry loss or formation breakdown.

★ on a liner string below a Halliburton Type "H" Solid Baffle Collar to hold cement pumped through the ports in the collar into basket to partially protect the producing zone or any lower formation from contamination.

★ on casing for a straight casing cementing job to help support the column of cement and give extra protection to any weak or porous area.

★ with EZ Lok Limit Clamps or Solid Set Screw Limit Rings for selective spacing of Baskets between casing collars *without welding*. Split Dent Limit Rings furnished with each Basket may be spot welded, if desired, on pipe above and below each Basket to permit movement of casing with Basket open.

For stronger, safer cementing, specify Halliburton Cement Baskets... and other Halliburton Cementing Tools and Equipment—"job-proven" on more than two million cementing operations. Contact your nearest Halliburton Representative for complete information.

HALLIBURTON
CEMENTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

"284 SERVICE CENTERS — JUST MINUTES AWAY FROM YOUR WELL"

New 15,000 psi tester includes automatic equipment for blowing out scale and dirt, stenciling, screwing on couplings, delivering pipe to tester, weighing after testing, screwing on thread protectors and spraying each length with oil.

SPANG's new pipe tester is unique

THE NATIONAL NSCO SUPPLY COMPANY

You can't produce the best quality tubular goods with ordinary facilities. So you obtain the best facilities available—even if, in some cases, the equipment is unique.

This new hydrostatic tester is such a facility. Added in our Ambridge, Pa. plant early this year, it's the only line production machine of its kind designed for a 15,000 psi pressure. It handles pipe up to 5½ in. O.D. and up to 48 ft. long, including plain end, threaded, coupled and upset pipe.

Modern facilities like this new tester insure the quality you always expect and get in Spang Tubular Products.

More on the next page—

STARS
STARS

Three points to remember when you buy drill pipe

1. A SPANG drilling string is a fully integrated string

National Supply is the only company in the industry manufacturing both the drill pipe and the tool joints. From this *single* responsible source, you get a string that has carefully controlled quality from start to finish.

2. SPANG leads in tool joint design—the critical area of pipe service life

Spangweld Tool Joints are welded to the drill pipe by an automatically controlled operation insuring accurate alignment and a high quality weld. The welding permits a streamlined contour and a reduced number of threaded elements. This tool joint connection also allows the smallest practical O.D. and maximum bore—a definite advantage for slim hole drilling.

Spang Double Seal Shrink Thread Tool Joints can be easily removed and replaced in the field. Joint design has an outer seal, threads and inner seal all on a single cone. This insures uniform, reliable installations both at the mill and in the field, and completely seals against internal and external pressures.

3. SPANG provides the best selective protection against corrosion and abrasion

Spang Plastic Coating—the result of ten years of research—gives the best protection against corrosion. Scientifically applied at the mill on specially-developed facilities, Spang Plastic Coating is available not only in Spang Drill Pipe but also Spang Casing, Tubing and Line Pipe.

Spang Hardfacing is a superior protection for tool joints in abrasive formations. It consists of multiple bands of tungsten carbide, *continuously* overlapped on the joint to form a solid particle-to-metal band.

Specific proof of these benefits is furnished every day in numerous locations throughout the world. The National representative in your area will be pleased to tell you more.

A National plant inspector checks the destination of an order of hardfaced Spangweld Drill Pipe. Spang Hardfacing consists of multiple bands of tungsten carbide, continuously overlapped on the joint to form a solid particle-to-metal band.

National Drill Collars on the next page . . .

National Drill Collars are simultaneously bored from both ends on this 165-ft. trepanning lathe designed especially for this purpose. The lathe's speed and accuracy obsolete the ordinary type of solid bar drilling.

Use precision-made National Collars for best penetration rates!

Are you looking for ways to improve penetration rates at all drilling speeds, and extend the life of your drill string? Specify National Drill Collars and you'll see new results because of these features:

High strength properties—National Collars are made from alloy steel, hardened and tempered *full length* (not just ends only) for high strength. As an additional safeguard against fatigue failure, National "Tuf-Flexes" its drill collar joints by cold-rolling or peening.

True center bores—These are established by a special 165-ft. trepanning lathe which precisely bores both ends of the collar simultaneously. All bores are carefully surveyed for concentricity to insure proper balance while rotating at normal and high drilling speeds.

Stress relief grooving—To improve the fatigue resistance of drill collar joints, National machines a stress relief groove at the last engaged thread zone of both box and pin members. The pin relief groove is designed to protect the shoulder corner as well as the stress concentrating zone at the last engaged thread.

Along with performace records, features like these are proof that you can't buy a better drill collar than National's. So get the best—and the operating benefits that go with it. See a National representative about the drill collar sizes to meet your needs. He can also give you some valuable tips on collar care and handling.

Replaceable End Collars

National also manufactures a complete line of drill collars with replaceable ends—incorporating a modification of the time-tested double seal shrink thread principle—for use in isolated areas where field shop facilities may not be available.

THE NATIONAL SUPPLY COMPANY

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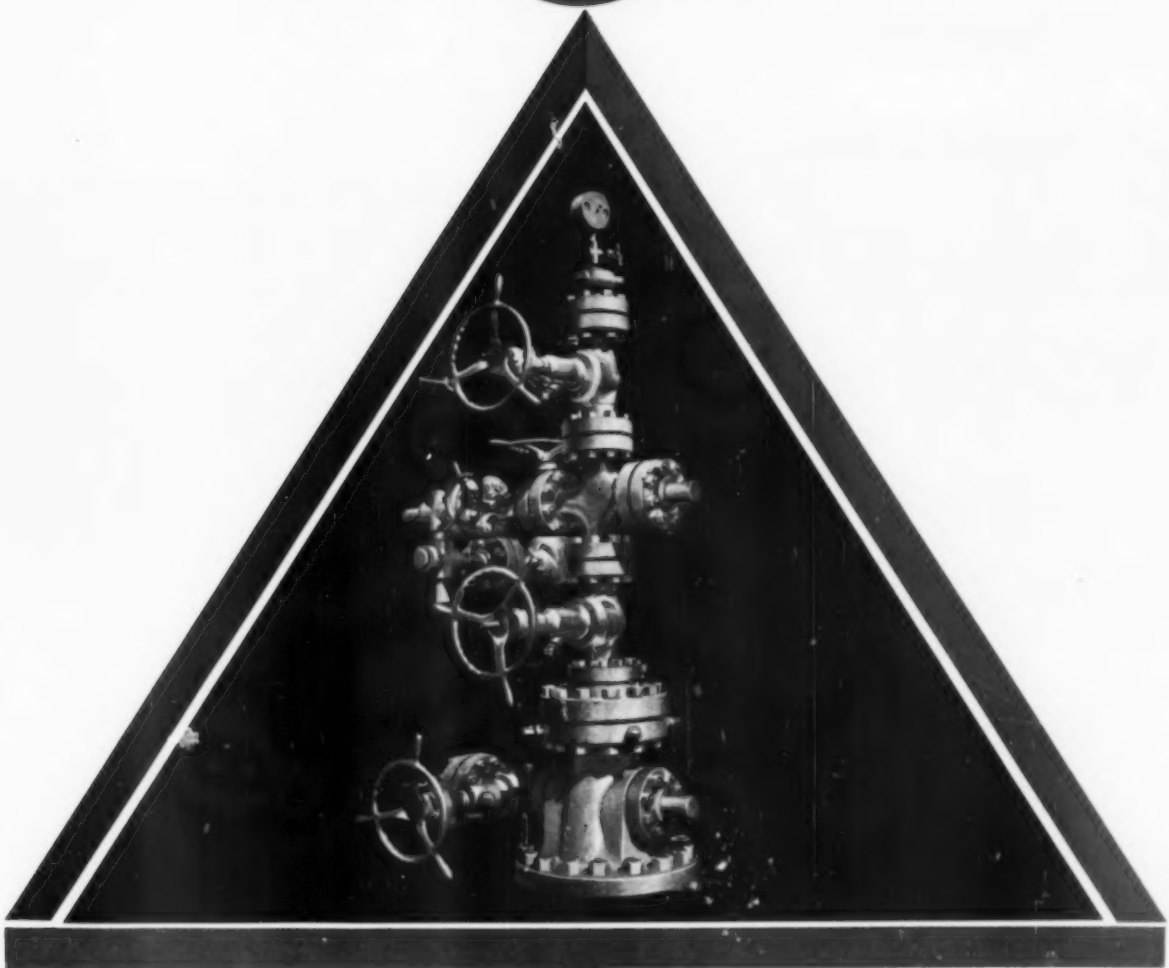


WE'D LIKE TO BE . . . ON YOUR CHRISTMAS TREE

This is the season in which to remember . . . and be remembered.

Orbit Valve Company's personnel — wherever they may be — appreciate the opportunity of serving a truly great industry during this year and the many years of the past.

We sincerely wish a Happy and Prosperous New Year for everyone throughout the oil industry.

ORBIT VALVE COMPANY • TULSA, OKLAHOMA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

ONE SOURCE...ONE RESPONSIBILITY
GARDNER-DENVER

Compressor

Cooling system

Controls

Prime mover

Packaging

Field start-up

Servicing

"HOW'S IT GOING TODAY?"

Your Gardner-Denver oil field specialist calls back after the sale . . . takes pride in knowing that all units are running to your satisfaction. Count on him for service in the hour of need. He represents our 100-year philosophy of growth: *There's no substitute for men.*

Consult Gardner-Denver for the gas compressor package that's Gardner-Denver-engineered *all the way*. Call our nearest oil field office or write for descriptive literature.

GARDNER-DENVER stocks compressor units in all standard types and sizes at our Dallas oil field plant.

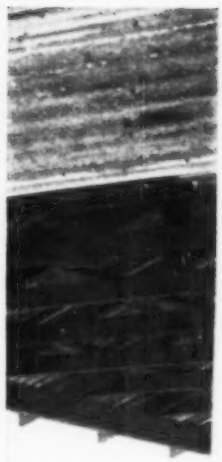
GARDNER-DENVER engineers the cooling system, separators, controls and other component parts of the complete package.

GARDNER-DENVER selects the power unit to perform efficiently and economically with the compressor load.

GARDNER-DENVER packages all components on a heavy steel skid . . . assembles and tests the unit to meet your needs.

GARDNER-DENVER ships directly to your field location . . . helps to install and place in operation.

GARDNER-DENVER provides field service to keep your compressor in top running condition.



EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

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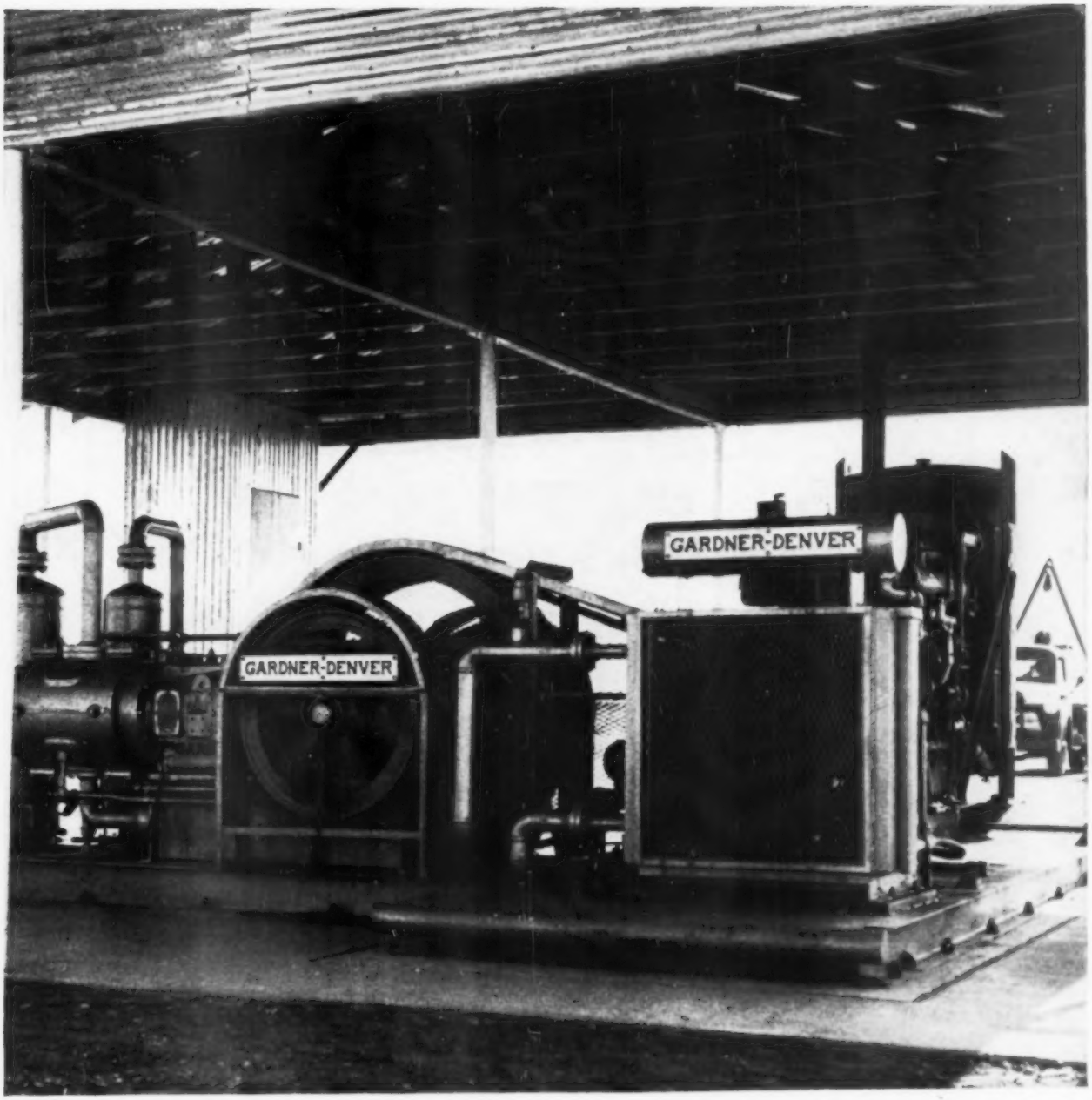
FOR YOUR ENGINEERED COMPRESSOR PACKAGE



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THE OASIS—

A gathering spot for NOMADS

Houston: New members initiated at the October meeting of the Houston Chapter of Nomads are: (seated, left to right) Cliff Jarrett, Lane-Wells Company; and Joe Stine, Joe C. Stine, Inc.; (standing, left to right) Elbert Walker, Magcobar; and Jess Adkins, THE PETROLEUM ENGINEER.

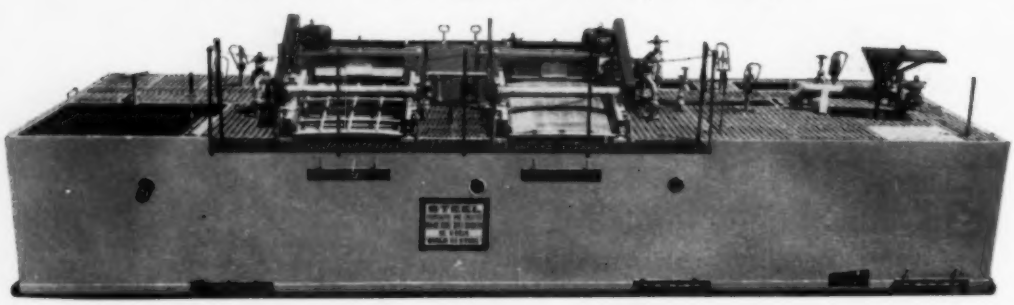
Houston: International visitors attending the regular October meeting of the Houston Chapter of Nomads were: (seated, left to right) S. D. Frazier, Gulf Oil Company of Libya; G. Gomez, Drillex of Argentina; and Tom Whittaker, Cameron Iron Works, Buenos Aires; (standing, left to right) D. W. Ward, Tennessee Gas & Oil Company, Calgary; Milton Eoff, International Drilling Company, The Hague; H. G. Rice, Importaciones Rice, Maracaibo; E. P. Hayes, Cal-Tex (retired); and B. T. Stark, Southeastern Drilling Company, Calgary.

New York: On October 5, the New York Chapter of Nomads held its monthly party in the Palm Terrace of the Hotel Roosevelt. Visiting guests at the party were: (seated, left to right) E. Kipps, Standard Oil of California; G. Hughes, Texaco, Trinidad; L. J. Cotterill, Kuwait Oil Company; E. A. Horne, Interoil, S.A., Bolivia; and H. Hollister, Oil Center Tools, Houston, Texas; (standing, left to right) W. Ganskopp, Creole Petroleum Corp., Venezuela; T. Ashe, Globe Oil Tool Company, Los Angeles; and E. Simian, E.N.A.P., Chile.

CAMDRILL

selected MEDEARIS UNITIZED MUD SUCTION TANKS

for their drilling operations in Libya



MEDEARIS *Oil Well* SUPPLY CORP.

Originators of Mud Control Systems

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DIRECTIONAL DRILLING • FISHING & CUTTING • ELECTRICAL WELL SERVICES • OILFIELD SUPPLIES • EXPORT TOOLS & SERVICE

HOMCO
HOUSTON OIL FIELD MATERIAL COMPANY
Fishing, Cutting

THE HOMCO WASHOVER DRILL COLLAR SPEAR

prevents drill collars from falling during washover operations

When you call Homco for a fishing or cutting job you know you are getting the most skilled help in the oil fields. Thirty one years experience in the field enables Homco to offer you an unequalled service. Trained and experienced operators use the Homco designed tools that get the job done fast.

As an example, in many instances drill collars are lodged some distance from the bottom of the hole and when washed over they fall to the bottom, necessitating an extra trip into the hole to retrieve them. And, in many cases the collars lodge on the bottom requiring additional washover operations.

The Homco Drill Collar Spear is designed to prevent this. This tool has the spear attached to the wash pipe through shear pins allowing the spear to be screwed into the joint connection of the collar. After the connection is made the pins are easily sheared, allowing washover to begin. The spear is in the catch position as the collars are washed over preventing the collars from falling. A free point indicator may be operated through this tool at any time.

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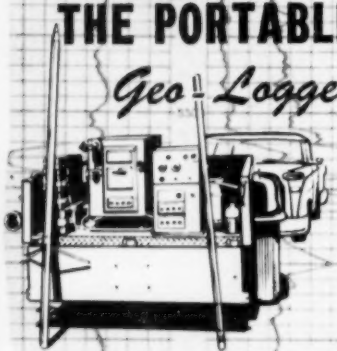
HOMCO has it!

CUT LOGGING COST!
WITH
THE PORTABLE
Geo-Logger



The Geo-Logger is a portable one-man operated unit that goes everywhere. It is designed to record several different type logs. The field proven models range from 750' to 6000'.

FOR THE FOLLOWING PROGRAMS:
- Water Floods secondary recovery
- Geophysical
- Gas Storage
- Core Drilling
- Production Drilling
- Workover

TYPE OF LOGGING AVAILABLE:
- Electric (S.P. & Res.)
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Operation of . . . Reciprocating Wire Line Packer Setting Tool

Mechanically operated tool sets squeeze packers, production packers, and bridge plugs efficiently and economically in well completion and workover

Frank Sharp
A. E. Cummins
Halliburton Oil Well Cementing Company
Duncan, Oklahoma

THE reciprocating wire line packer setting tool is a mechanically operated tool for setting squeeze packers, production packers, and bridge plugs. The setting tool will set packers and plugs efficiently and economically, resulting in a saving for the operator.

Using Plugs and Packers

Setting of bridge plugs and permanent-type drillable packers has long been one of the standard procedures in well completion and workover operations. These packers and plugs are used for many purposes, including (1) aid in isolation of one or more zones for producing, squeezing, or treating, (2) temporary or permanent plugging of a zone.

Construction of these packers includes primarily a packer element for sealing and two sets of slips for anchoring against movement in either direction. The setting mechanism is ordinarily embodied in a separate device, or setting tool, which is removed from the well after setting the packer to cut down on the amount of material to be drilled when the packer is to be removed.

Purpose of the setting tool is to force the two sets of opposing slips toward each other, compressing the packer element and causing it to seal inside the casing. Slips then hold the packer element in the set position.

Permanent drillable bridge plugs and packers can be set in casing by any one of several methods. Selection of the method to be employed usually depends upon several factors:

1. Well conditions

Depth at which a packer is to be set governs the length of time required. At relatively shallow depths the small amount of time required may not be too important, but in deeper wells where running-in time becomes appreciable, consideration should be given to selecting a setting method which will permit the greatest running-in speed and at the same time provide for positive setting of the packer.

Some setting devices are affected by extreme pressure and temperature conditions. Mechanically actuated setting devices are generally unaffected by these factors, however.

Mud weight and condition of mud also affect the running-in speed. Sometimes it is difficult to run enough weight with wire line tools to get the packer down in a reasonable time in extremely heavy, viscous mud. In such cases it may be necessary to run the packer on tubing.

Deviation of the well bore and obstructions in the casing may make it desirable to select a particular method of setting.

2. Associated work

The work which is to be performed subsequent to setting of the packer often plays an important role in the selection of the setting method. If a plug is to be run and the casing perforated it may be more economical to set the plug on an electrical wire line if other conditions are favorable. If the well is to be squeeze cemented, treated, produced, or any other work

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done which utilizes the running-in string and the setting device, it may prove to be economical to run the packer on tubing.

3. Adaptability of packer to types of setting

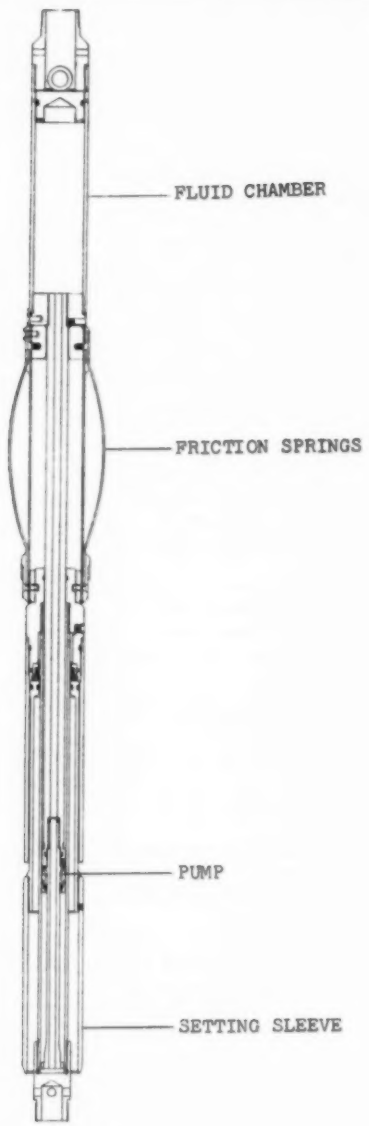
If a packer is designed to be set with one type setting device best results would probably be obtained by using this method. The success record of proper setting with different setting tools and packers should be considered in selecting a setting device.

Almost every factor affects the cost of setting a packer. Time involved is one of the most costly factors and therefore should be carefully considered. Other related charges may also change the economic picture.

There are several types of setting tools available for use on both wire line and tubing. Most common tubing type setting tool is a mechanical tool which employs friction members such as drag springs or drag blocks to permit rotation or other manipulation of the tubing. Tubing pressure is used in some cases in a hydraulic tool to actuate a piston to transmit force to the packer.

Most common wire line type setting tool uses the gas released by a burning propellant as a source of power to set the packer. Another wire line type uses the hydrostatic head as a source of power after a valve is opened by either electrical or mechanical actuation to permit entry of the well fluid into the setting tool.

Each of these methods has certain advantages along with some undesirable features. A new mechanical wire line setting device is now in service which incorporates many of the desirable features of the other types.



WIRE LINE - HYDRAULIC SETTING TOOL

FIG. 1

Description

The reciprocating wire line setting tool, Fig. 1, is a tool that can be operated with a low strength mechanical wire line to set drillable production packers, squeeze packers, and bridge plugs. The setting tool is not affected by temperature nor pressure. It can be retrieved with the packer if, for some reason, it is desirable to do so after the packer and setting tool have been run into the well. The setting tool can be used to set packers in dry or fluid-filled wells.

The reciprocating wire line setting tool contains a hydraulic jack, consisting of two pistons and cylinders, one small and one large. These components are operated by the wire line that is used to run the setting tool with plug or packer into the well. A back pressure valve for pressure build-up is located above the setting sleeve so that hydraulic pressure applied to the setting sleeve by the pump cannot be released until the packer is set. A set of drag springs is attached to the outside of the tool to help prevent the plug or packer from moving down the hole during the pumping operation before the top packer slips are set.

Construction of the setting tool is such that it requires a wire line or cable with a minimum of 3000 lb tensile strength plus line weight to set a packer requiring 30,000 lb setting force. Normally any sand line or swab line is adequate.

The bridge plug, squeeze or produc-

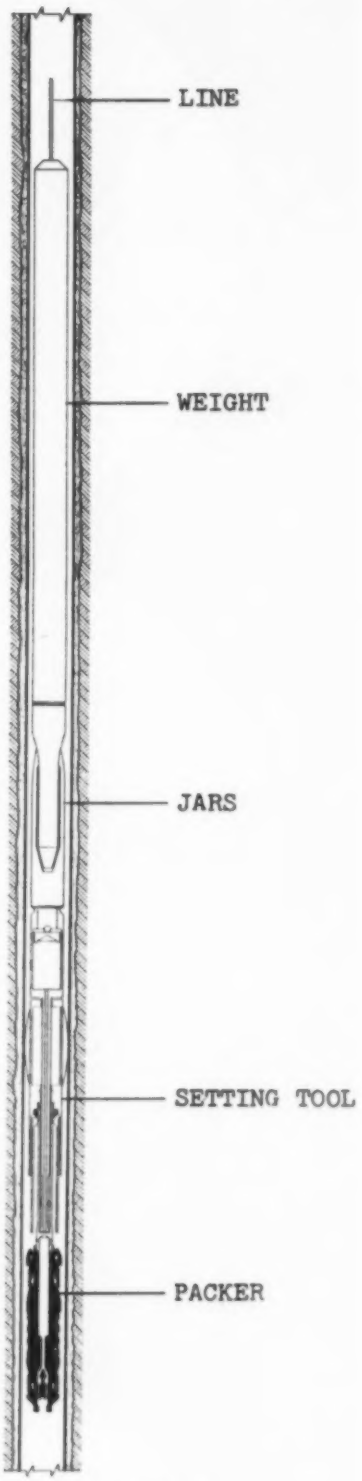
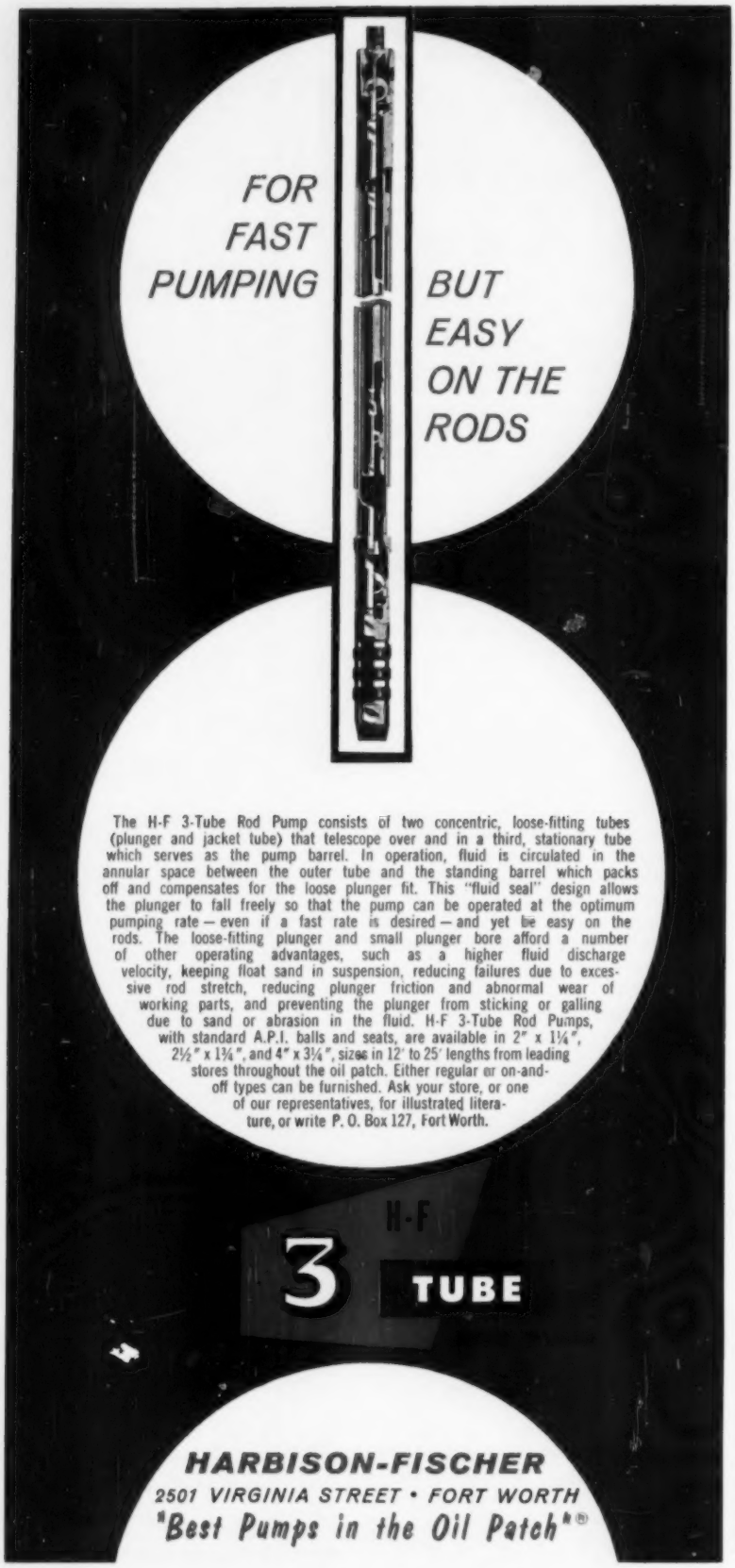


FIG. 2


FOR FAST PUMPING
BUT EASY ON THE RODS
The H-F 3-Tube Rod Pump consists of two concentric, loose-fitting tubes (plunger and jacket tube) that telescope over and in a third, stationary tube which serves as the pump barrel. In operation, fluid is circulated in the annular space between the outer tube and the standing barrel which packs off and compensates for the loose plunger fit. This "fluid seal" design allows the plunger to fall freely so that the pump can be operated at the optimum pumping rate — even if a fast rate is desired — and yet be easy on the rods. The loose-fitting plunger and small plunger bore afford a number of other operating advantages, such as a higher fluid discharge velocity, keeping float sand in suspension, reducing failures due to excessive rod stretch, reducing plunger friction and abnormal wear of working parts, and preventing the plunger from sticking or galling due to sand or abrasion in the fluid. H-F 3-Tube Rod Pumps, with standard A.P.I. balls and seats, are available in 2" x 1¼", 2½" x 1¾", and 4" x 3¼", sizes in 12' to 25' lengths from leading stores throughout the oil patch. Either regular or on-and-off types can be furnished. Ask your store, or one of our representatives, for illustrated literature, or write P. O. Box 127, Fort Worth.
H-F
3
TUBE
HARBISON-FISCHER
2501 VIRGINIA STREET • FORT WORTH
"Best Pumps in the Oil Patch"®

tion packer is attached to the bottom of the setting tool assembly as shown in Fig. 2. A weight of 300 to 500 lb, enough to push drag springs and packer into casing, must be added on top of the setting tool. Weight used may be a link jar, sinker bar, or other weight with proper connection.

The hydraulic pump in the tool is operated by taking a 20-in. upward stroke with the line. Six full pump strokes are required before any force is applied to start setting top slips. This provides a safety factor for accidental pump strokes while running the device into the well. Continued pumping shears the pins, sets the bottom slips, and expands packer rubbers.

Pressure build-up by the pump is accomplished by a small piston moving fluid into a larger cylinder. As this action takes place, fluid acting on the piston in the larger chamber develops approximately 12 times the amount of force on the tension sleeve or pin as the amount of pull taken on the wire line.

When sufficient pressure has been built up in the setting sleeve chamber, tension sleeve, or pin parts, the setting tool is free for removal from well. Approximately 15 to 18 full strokes are required to set the packer and part the tension sleeve or pin. If additional strokes are taken, no damage should result to the setting tool or packer.

Summary

Use of the reciprocating wire line setting tool for setting bridge plugs, squeeze and production packers offers many desirable features:

1. Tool can be used in wells with or without fluid. The necessary hydraulic fluid to operate the tool is carried in the tool.
2. It eliminates special set-up for electrical wire line.
3. Sand line or swab line on rig can be used to operate the setting tool.
4. Rig time is saved where tubing normally would be used in the setting operation.
5. Accuracy in placement is accomplished by tagging bottom, flagging the line, or the use of a depthometer on the running-in line. Collars can be located if run on electrical line.

Work is now being done on a combination weight indicator and measuring device to be used on a sand or drilling line. This work is being done so that more accurate measurement may be obtained with a sand line. ★ ★

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Announcing the NEW

BJ Centrilift

Submersible Motor Centrifugal Pump

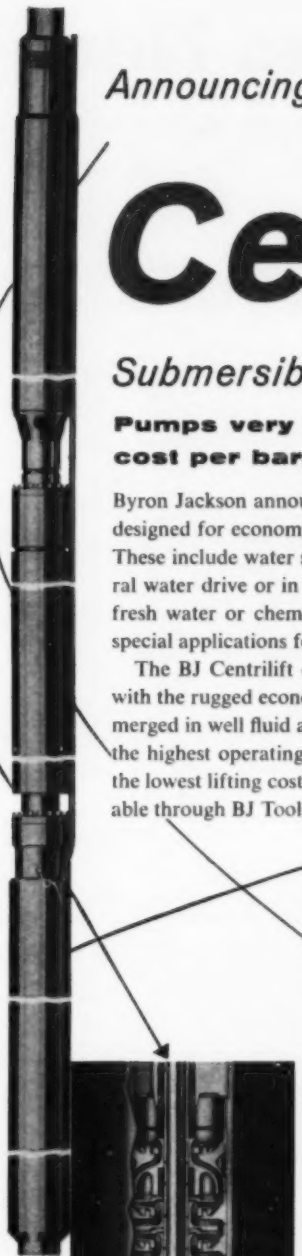
Pumps very large volumes of fluid at lowest cost per barrel!

Byron Jackson announces the BJ Centrilift—a new sub-surface oil well pump designed for economy and dependability over a wide range of industry needs. These include water supply wells in flood projects... production wells in natural water drive or in artificial floods with low oil/water ratio... deep wells... fresh water or chemical brine wells... crooked or whip-stocked wells... and special applications for severe corrosive or abrasive conditions.

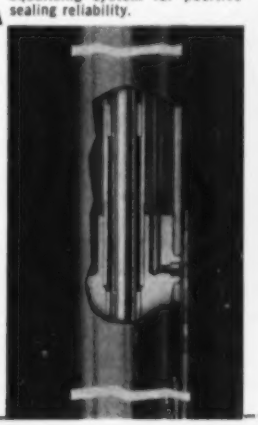
The BJ Centrilift combines the extra capacity of centrifugal pump design with the rugged economy of a close-coupled BJ Submersible motor drive. Submerged in well fluid and suspended on standard tubing, the BJ Centrilift offers the highest operating efficiencies with the lowest horsepower requirements... the lowest lifting cost per barrel of fluid. Fast, dependable field service is available through BJ Tools' network of plants, warehouses and field service centers.

A product of more than 87 years of centrifugal pump leadership

Byron Jackson has been a leading pump manufacturer since 1872... pioneering in centrifugal pumps, including both deepwell turbine and submersible motor types. From this 87-year background of experience and leadership comes the great new BJ Centrilift—designed to serve a growing need for superior sub-surface pumps for the oil industry.



SEAL SECTION. BJ Centrilift utilizes multiple mechanical seals, combined with simple pressure equalizing system for positive sealing reliability.



MOTOR. Byron Jackson-built motor is of the squirrel cage induction type... oil-filled to prevent internal corrosion and provide long, maintenance-free operation.

PUMP. Capacities of 500 to 17,000 BPD, in as many stages as required for operating head. Diameters to fit well casing sizes of 5½", 7", 8⅝". Bowls, impellers and shafting of corrosion-resistant materials for long life, low maintenance.

MAIL THIS COUPON FOR ADDITIONAL INFORMATION

Please send price and performance data on BJ CENTRILIFT equipment for the following application:

WELL NAME _____ WELL NUMBER _____

WELL LOCATION: FIELD _____ COUNTY _____ STATE _____

DEPTH _____ CASING SIZE _____

PRESENT PRODUCTION, BPD _____

DESIRED PRODUCTION _____ ESTIMATED LIFT _____

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

Byron Jackson Tools, Inc.
Oil Well Pump Section
A Subsidiary of Borg-Warner Corporation
P.O. Box 3098, Tulsa, Oklahoma • Telephone: WEbster 2-3242

AAODC Names New Officers,

Recipients of the first Meritorious Service Awards presented by the American Association of Oilwell Drilling Contractors display the handsome trophies representing the awards. They are (left to right): Stanley Moore, Drilco Oil Tools, Inc., Midland, Texas; Will I. Lewis, Will I. Lewis Drilling Company, Mt. Vernon, Illinois; John Woodruff, University of Texas, Austin, Texas; Earle C. Flesher (seated), Johnson & Flesher Drilling Company, Oklahoma City; H. W. Davidson, who received the plaque for his brother, C. J. Davidson, Davidson Drilling Company, Inc., Fort Worth, Texas; F. A. York, Miller & York, Inc., Bakersfield, California; Henry Woods, Hughes Tool Company, Houston, Texas; and Arthur Lubinski, Pan American Petroleum Corp., Tulsa, Oklahoma.

HONORED for their outstanding contributions to the drilling industry, eight men were presented Meritorious Service Awards by the American Association of Oilwell Drilling Contractors at its 19th annual meeting, October 11-13, in Oklahoma City.

The awards, presented for the first time this year, are designed to pay special tribute to both members and nonmembers of the association who have advanced the science and status of the oil well drilling industry.

Three individuals, whose correlated work has resulted in much valuable information on crooked hole drilling, were selected as co-recipients of one award and were cited for "extremely valuable contributions to the development of mathematical formulae and the application of these formulae. This work has assisted materially in the solving of problems arising from hole deviation, one of the most frequent and troublesome difficulties encountered in the drilling of oil and gas wells." These men are Arthur Lubinski, Henry Woods, and Stanley Moore.

C. J. "Red" Davidson received the award "for his extremely unselfish and untiring efforts on behalf of the association, for his willing sacrifice of personal time and money in seeking to improve the contract drilling business, and for his frequent wise counsel and guidance which have contributed immeasurably to solving many difficult problems."

Earle C. Flesher was cited "for long untiring and distinguished service as a loyal director, as chairman of several standing and special committees, and as vice president of the association. Special recognition is given for the sincerity, tact, and judgment he has exhibited as a leader whose counsel often was followed when difficult association and industry problems arose."

Will I. Lewis was honored "for his eager participation and tireless work on behalf of AAODC since its organization. His candid advice, staunch devotion, and piquant wit have enhanced the stature of contract drilling, and have had much to do with AAODC attaining a position of respect and wide influence in the industry."

John Woodruff was rewarded "for his extremely valuable contribution to the progress of oil well drilling during the past 15 years, through his development of training manuals, films, and schools for field personnel. These have contributed immeasurably to the advancement of operating practices and thereby to the economic status of the drilling industry."

F. A. "Pug" York received the award "for his outstanding record for long unselfish and tireless services on behalf of the drilling business and of this association. His efforts have helped to advance the well being of and respect for the drilling industry and the association at both regional and national levels."

Makes First Service Awards

AAODC Officers for 1960 are (seated, left to right): secretary-treasurer, E. Dale Mount, Dale Mount Drilling, Inc., Dallas; president, W. L. McClusky, M. J. Delaney Company, Dallas; national vice president, Herbert Woolf, Woolf & Magee, Inc., Tyler, Texas; executive vice president, Warren L. Baker, Dallas; general counsel, Joseph M. Shelton, Dallas; (standing, left to right) vice president for North and West Central Texas, R. J. Moran, Moran Drilling Company, Wichita Falls, Texas; vice president for Cable Tools, F. M. Stevenson, Signal Drilling & Exploration, Inc., Denver, Colorado; vice president for West Texas and New Mexico, R. C. Tucker, Great Western Drilling Company, Midland, Texas; vice president for Illinois, Michigan, Indiana, and Kentucky, Don Slape, Don Slape Drilling Company, Olney, Illinois; vice president for offshore, G. B. Kitchel, Kerr-McGee Oil Industries, Inc., Houston; vice president for California, Hugh M. Gallagher, Camay Drilling Company, Los Angeles; vice president for Rocky Mountain, M. E. Peden, True Drilling Company, Casper, Wyoming. Officers not in photograph are: vice president of Gulf Coast, J. Geer Wilcox, Circle Drilling Company, Inc., Lake Charles, Louisiana; vice president for Central Mid-Continent, J. L. Stauss, Falcon Seaboard Drilling Company, Tulsa, Oklahoma; vice president for Cretaceous and Tertiary Basins, A. Earl White, Mustang Drilling Corp., Tyler, Texas; and vice president for Well Servicing, E. F. Fullen, Mallard Well Service, Lafayette, Louisiana.

FIRST STRIKE IN SEA OF JAPAN OPENS FAR EAST OFFSHORE ACTIVITY

A "PORTABLE ISLAND" imported from Texas has hit the first offshore gusher in the Far East, the Oil Resources Development Corporation (ORDC) has announced.

A well sunk in the Japan Sea, 7216 ft off Akita City, about 340 miles north of Tokyo, gushed an estimated 2000 bbl of oil with about 375,000 cu ft of gas, an ORDC spokesman said.

"This is an extremely rich well for Japan," the spokesman added, "and we are quite pleased."

The well was drilled from a 4000-ton triangular platform imported from R. G. LeTourneau Inc. of Longview, Texas. The platform was launched near Akita on September 8, 1958.

"It sank two other wells near Michikawa about 10 miles south of the present site," the spokesman said. "The two wells yielded some oil, but not to the extent of allowing us to drill offshore. The portable island was moved to Akita last April 2."

He said the portable island named "Hakuryu" (White Dragon) will be moved 10 miles further to the north to drill another well.

The White Dragon is operated by 45 Japanese technicians who live on the platform and plan eventually to sink scores of wells in the underseas deposits. The deposits are believed to extend some 30 miles on the Japan Sea continental shelf about 30 to 90 ft deep.

The new Akita well was sunk 4766 ft deep from a 50-ft deep spot on the continental shelf. The oil came from a formation about 1800 ft deep from the sea bottom.

R. L. LeTourneau of Longview, vice president of the company, spent two weeks in Japan negotiating the $1,-500,000 sale in spring of last year. While the platform was built in a Japanese shipyard, all major components were manufactured in Longview and shipped to Japan.

See the January Issue for Complete Japanese Story

Joseph A. Kornfeld, Tulsa consultant, is the author of an article to be published in the January issue of THE PETROLEUM ENGINEER which will present the complete story of the Japan sea discovery.

According to Kornfeld, the strike near Akita "crowns a decade of underwater exploration conducted offshore from Akita Prefecture commencing back in 1949." The article includes discussions of exploratory drilling in Japan, geographic and geologic features, hydrocarbon occurrences, and production figures, as well as maps of major oil fields, a geologic correlation table, and a summary of Japanese oil legislation and tax laws.

HALLIBURTON ACIDIZING

"Round-Up"...

a right type acid for the right zone

Because every well is not the same, varied acidizing materials and techniques are necessary for superior results.

Halliburton has available many basic chemicals and additives that may be combined in different ways to satisfy most special well conditions.

Halliburton Acidizing Services and Halliburton trained and experienced operating personnel can aid in helping you determine the right type acid for the right zone... helping to increase production in new wells and improve production in older wells.

After a careful and complete analysis of your formation requirements, determined by a Halliburton Chemical Laboratory examination, one or a combination of these Halliburton additives may be the "stimulation factor" for profitable production results.

HALLIBURTON REGULAR ACID...
an effective and economical stimulation aid for most limestone and dolomitic formations.

HALLIBURTON NON-EMULSIFYING ACID...
a composition of regular acid, plus an individually selected Halliburton "N" compound designed to aid in preventing emulsions during acidizing. Halliburton "N" agents may also be sediment dispersants which act by oil coating the insoluble silicates while leaving the calcareous rock water wet.

HALLIBURTON PENETRATING ACID...
composed of regular acid plus an additive for surface tension reduction. The surfactant effectively lowers the surface tension of both raw and spent regular acid and can also be used with other acid mixtures. Its greatest application is in formations normally requiring prolonged "clean-up" time after treatment which may be due to "jamin-effect".

HALLIBURTON MUD CLEANOUT AGENT (MCA)...
regular acid containing a unique synergetic blend of surfactants called Morflo II. This Morflo II-Acid combination, MCA, is specifically designed to remove flow restrictions caused by water, emulsions and/or solids.

HALLIBURTON HV ACID...
its name implies high viscosity. Retards chemical reaction of acid on limestone formations allowing penetration of unreacted acid a greater distance from bore hole. Also used as diverting agent.

HALLIBURTON Fe ACID...
a regular penetrating acid with a conditioning agent to minimize re-precipitation of dissolved iron salts and oxides during acidizing. Best suited where abnormal amounts of iron are dissolved by acid prior to its spending on formation, such as conditions associated with disposal and injection wells.

HALLIBURTON HF ACID...
a combination of hydrochloride and hydrofluoric acids specifically designed for treatment of siliceous formations.

HALLIBURTON ACID INHIBITORS...
a necessary protective additive used in all Halliburton acid solutions to reduce reaction on downhole equipment.

When you consider the stimulation benefits of Halliburton acids and inhibitors... there can be no other acidizing choice!

Help your well to get the right type acid for the right zone.

HALLIBURTON CHEMICAL SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

New Visco Well-Treating Formula Penetrates, Loosens, Disperses Deposits in Tanks, Lines, Tubing

Lowered pumping pressure, Tripled production, Dispersed solid paraffin... Among Spectacular Performance Results with Visco 1111

Visco 1111, on the job in oil and gas producing wells, water-injection wells and salt water disposal systems, has amazed even the most optimistic with its performance and economy. Here are a few examples of how it works to penetrate, loosen and disperse deposits of paraffinic-asphaltic compounds, carbonate scale, sodium salt deposits, iron compounds and other materials causing loss of production.

Cuts Pumping Pressure 175 psi

Injection pressure was 325 psi on a water injection well. Foreman believed pressure was due to a tight formation, but agreed to a test of Visco 1111. Pressure is down to 150 psi—and staying there, with one-gallon-per-day dosage of Visco 1111.

7-Well Cleanup Nets 60 bbl. Increase

Sticking pumps, caused by scale build-up, were causing frequent rod-pulling jobs on a 7-well East Texas lease. Visco 1111 cleaned up the pumps and tubing, upped production 60 bbl. per week. Company now using Visco 1111 on all their wells in East Texas.

Stopped Reperforating Need

On another East Texas lease, wells making high salt water with low-gravity oil tended to scale up and require periodic reperforation. Visco 1111 was given a trial on a well making only 3 bbl. oil and 20 bbl. water a day... quickly jumped daily production to 23 bbl. oil and 60 bbl. water. Cost: only $23.50 . . . as against $300 to reperforate.

Solid Foot of Paraffin Gone

A 500 bbl. tank contained 470 bbl. oil and a 12-inch paraffin bottom—so hard that an oil thief would not drop through. 5 gallons of Visco 1111 and 48 hours later the tank went on at 0.5% B.S. & W., *and no bottom at all.*

Easy to Use, Too!

Visco 1111 has excellent blending characteristics under a variety of field conditions, and does not gel when added to water. Your Visco Service Man will be glad to help you determine proper Visco 1111 dosages for best performance and economy on your leases. Ask him about this new well-treating product . . . or write us, today, for detailed product data.

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

EXPLORATION ACTIVITY

LIBYA

Socony's New Oiler Follows Five Dry Holes

Socony Mobil Oil Company has announced that its affiliate in Libya has discovered oil in a wildcat well 190 miles southeast of Benghazi. The discovery, known as Amal 1, is about 100 miles from the Mediterranean Coast.

The well flowed 865 bbl of 34-gravity oil in a preliminary 24-hr production test in the interval between 9841 and 10,405 ft. The discovery well was drilled to a depth of 11,990 ft and plugged back. It is in Mobil's concession number 12, totaling about 2,000,000 acres.

This is the easternmost discovery in Libya and is the sixth well that Mobil has drilled in that country. The first five were dry holes, though two of them showed indications of oil.

BRITISH ISLES

BP Makes Marine Survey Off U.K. Coast

Following the discovery of a limited quantity of oil at Kimmeridge in Dorset earlier this year, BP Exploration Company is carrying out a water-borne geophysical survey off the south coast of Dorset and the southwest coast of the Isle of Wight, on the edge of the English Channel. Object is to obtain new information regarding the geological structure of the rocks beneath the sea bed. This is the second water-borne geophysical survey that BP has carried out in the area; the first took place in 1956.

CALIFORNIA

New Fault Block Found In Arbuckle Gas Area

An extensive new fault block was discovered by Occidental Petroleum Corporation in the Arbuckle gas field area of the Sacramento Valley with successful dual completion of a new well. Results on the new well, Arbuckle Unit W-1, located in the northwest corner of Section 34, T14n, R2w, Colusa County, show that production was found in eight zones between 5520 and 6655 ft, with flowing pressures up to 1810 psi and bottom-hole pressure up to 4000 psi.

Six drillstem tests indicate an aggregate initial potential of 18,000,000 cu ft of gas per day. Additional logging checks reveal the possibility of another 12,000,000 cu ft per day from zones not yet tested.

NOVA SCOTIA

Imperial Spuds Test In Cape Breton

Drilling operations have begun at Imperial Oil's first exploratory well in Cape Breton. The well, Imperial-Mabou No. 1, is located approximately five miles south of the village of Mabou on the west side of the island.

The rotary drilling equipment being used to drill this well was originally moved to the Maritimes from western Canada by Imperial early in 1958 and has just completed a dry hole at Port Elgin, New Brunswick.

ARGENTINA

Gas Discovery Drilled In Rio Negro Province

YPF, the Argentine state petroleum agency, has made discovery of natural gas at a depth of 1520 ft in a well being drilled in the Province of Rio Negro. Location of the well, designated R.C.O. 1, is about 75 miles north of the town of Neuquen and about 8 miles from the town of Colonia Catriel. The flow of gas is reported to be about 2,100,000 cu ft daily and appears to be the first liquid hydrocarbon find.

NEW MEXICO

Wildcat Being Drilled Near Lovington

A Townsend Lime test, the No. 1 Sue A. Robinson, is being drilled by Trice Production Company in Lea County, six miles northeast of the townsite of Lovington. The wildcat is on an 800-acre block and is projected to a depth of 11,800 ft.

The prospect is located northeast of two producing Townsend Lime fields: the Kimnitz (Wolfcamp) field, 18 miles to the southwest, and the Townsend pool, 11 miles to the southwest.

AUSTRALIA

Conorada Acquires Queensland Concessions

Oil exploration concessions in Australia totaling 5,312,000 acres have been awarded Conorada Petroleum Corporation, owned by Continental Oil Company, The Ohio Oil Company and Amerada Petroleum Corporation.

The concessions granted Conorada are located in the heart of Queensland, a rugged, industrially undeveloped area in northeastern Australia. The concessions straddle the Tropic of Capricorn and cover an area about the size of the state of Massachusetts.

TEXAS

Conglomerate Discovery Opens New Field

Bayview Oil Corporation, et al, have a Conglomerate formation discovery in southeastern Throckmorton County. The J. T. O'Dell Unit No. 1, in a new field designation (Nedes field) was completed through perforations between 4444-48 ft. This wildcat potentialed 40 bbl of 42-gravity oil per day through a 10/64-in. choke. Gas-oil ratio was 1250 to 1; flowing tubing pressure registered 120 psi. Bayview owns a one-half interest in 320 acres in the immediate area.

Southeast Texas 'Cat Will Test Three Sands

Drilling operations have begun on Trice Production Company's No. 1 E. L. McDonald, located on a 264.5-acre block in San Jacinto County, some 13 miles south of Coldspring. The wildcat is projected to a depth of 8600 ft and will test Cockfield and Yegua sands at 5000 to 5100 ft, and the Mercy sand at 8300 to 8400 ft.

The site is 7½ miles due east of the oil-producing Mercy and Mercy West fields. Gas-productive Pelican field is about 3½ miles to the south. Lick Branch field, producing oil, gas, and distillate, is 5½ miles to the southwest.

Lipscomb County Extension Awaiting Connections

An important extension of the Tonkawa gas-producing formation in their 3520-acre block in Lipscomb County has been announced by Falcon-Seaboard Drilling Company. The Duke No. 1 in Section 817, Block 43 of the H&TC RRC Survey made 5,400,000 cu ft of gas on a potential test from a section of 42 ft in Tonkawa sand. The well was drilled to a total depth of 9821 ft and plugged back to 6582 ft. After completion, the well was shut in waiting for pipeline connections.

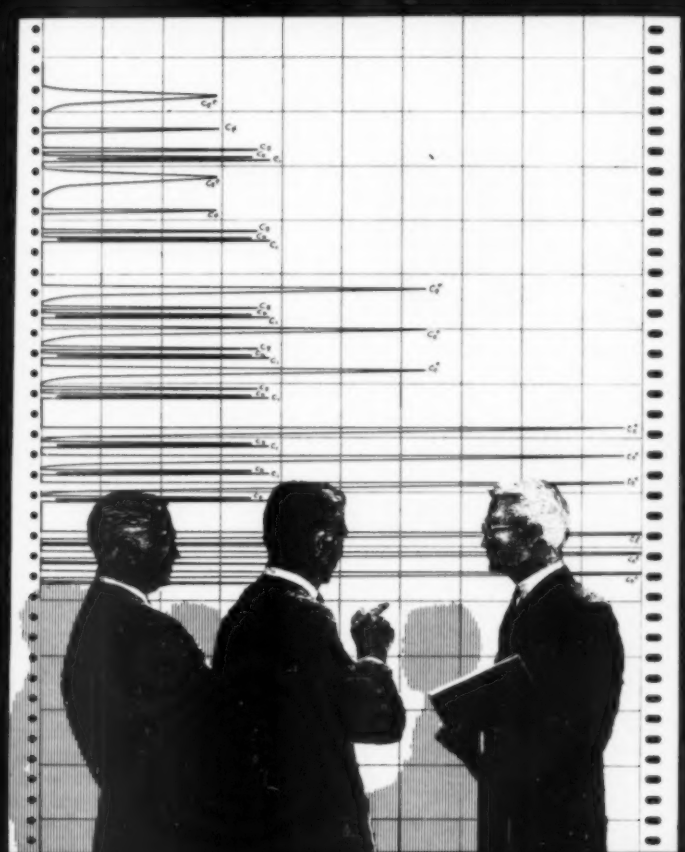
MISSISSIPPI

Petrofina Discovery In New Reservoir

American Petrofina Company of Texas Board of Supervisors No. 1, Section 16, T3n, R7e, Boykin Church field, has opened a new producing reservoir for the field. Perforated in the Hosston formation, the well flowed at 7 bbl per hr of 40-gravity oil on an 8/64-in. choke, with tubing flowing pressure at 1525 psi. Gas-oil ratio is 525 to 1.

P/H/D

Programmed Hydrocarbon Detector



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Heavier hydrocarbons are grouped together and recorded in an easier-to-see peak. *You can't miss them!*

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NEW WELL LOGGING PACKAGE CUTS COSTS... PROVIDES EXTRA INFORMATION

Continuous chromatographic monitoring and analysis of gas shows . . . *along with recording of principal drilling functions* . . . are combined in Hycalog's new GR-FDR package. And automatic operation permits the use of this equipment with *only one* attendant.

The package includes *two complete recording networks* . . . HYCALOG GAS CHRONOFRAC and a hot wire detector. One monitors methane content of mud gas samples and analyzes shows; the other records total combustible gases.

Added to this is the MARTIN-DECKER recording network which automatically measures and records the following drilling functions: weight on bit, pit level, pump pressure, and pump speed. (Recording of other functions such as torque and rotary speed are optional).

A *single* operator compiles and forwards daily all recorded data along with the log of any shows encountered.

With the new GR-FDR package you are sure of getting *round-the-clock* information at a cost far below regular well logging service.

Write for facts on the GR-FDR package. *And, while you're at it, ask about* HYCALOG V-DOOR *diamond drill bits.*

Hycalog, Inc.

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B-110

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Exploration

MICHIGAN

Ambassador Will Drill In Lenawee County

Ambassador Oil Corporation has announced it will drill a wildcat in south-central Michigan, to be known as the Ambassador-Emmett Sawyer No. 1, located in SW NW NE Section 18, T5s, R1e, 12 miles south of Jackson. Closest production is in the Scipio field 14 miles to the west. The well will test the Trenton and Black River dolomites. The company has a ⅞ interest in 7000 acres in the area.

Efforts to prove up a Trenton-Black River trend that has already produced three promising oil fields have transformed south-central Michigan into one of the most active oil plays east of the Mississippi River.

LOUISIANA

Offshore Test to Extend Salt Dome Production

Pan American Petroleum Corporation has begun drilling operations on its OCS 0572 No. 1, a Eugene Island area offshore exploratory test in the north portion of Block 208 field. The well is located some 45 to 50 miles from the Louisiana shore on a 2500-acre lease. Texaco, Inc. has 50 percent interest. The well is projected to a depth of 14,000 ft and will seek to extend production on the north flank of a salt dome.

PAKISTAN

Pakistan's First Oil Find Confirmed

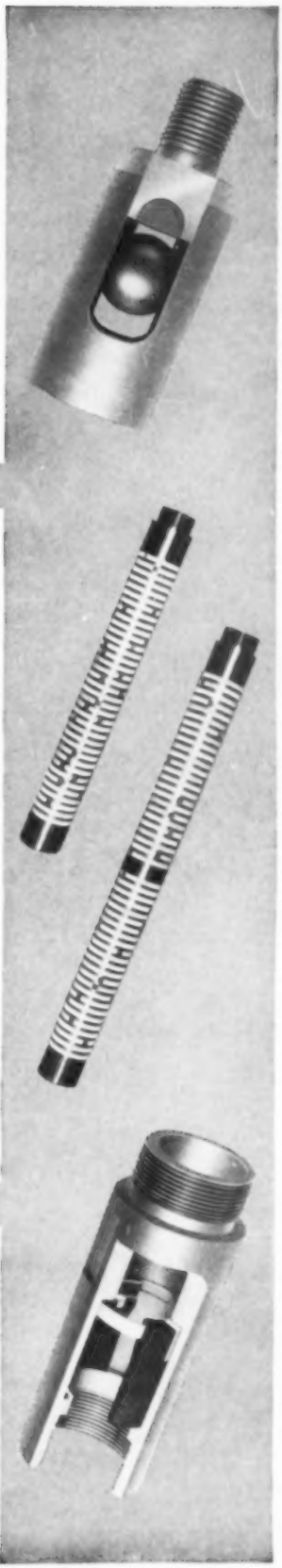
Pakistan's domestic production of crude oil may rise by approximately 20 percent when Karsal Well No. 3 is shortly put on regular commercial production. First shows of oil were found when drilling had progressed to a depth of 11,664 ft in the Eocene limestone. Following two acid treatments, the well is capable of producing steadily about 800 to 1000 bbl of oil per day.

ARKANSAS

Test to Be Drilled On White County Farmout

Ambassador Oil Corporation will drill the Ambassador-J. A. Stribling No. 1, a wildcat located in Section 14 T6n, R8w, in White County, 35 miles northeast of Little Rock. The well, approximately 50 miles due east of closest production in the Morrilton pool, will test the Atoka and Morrow sands to a depth of 4600 ft. It is being drilled on a farmout from J. K. Wadley, Texarkana, independent operator, on a 29,000-acre block owned by Wadley. By drilling the well, Ambassador will earn a full interest in approximately 13,000 acres.

Getting **Value Received** is a prime requirement in your efforts to REDUCE LIFTING COSTS. Giving value received has always been our prime objective.



THE MARTIN PLUNGER is valuable to you because it can be used over and over by replacing only the rings — **plus** the bonus of longer tube life, due to slower wearing action of the resilient rings.

THE MARTIN RUBBER GUIDE CAGES are valuable to you because of their remarkable lasting qualities — **plus** the bonus of improved Ball & Seat life.

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IMMEDIATELY AVAILABLE . . . in all sizes and styles from our Tulsa plant. Sold by all supply companies and stocked at many points. Fully detailed in Composite Catalog, except for recent improvements mentioned in our new 1960 Catalog.

The Plungers illustrated are our new standardized 1½ ft. and 2 ft. lengths which screw together to make longer (Box & Pin, cage thread) plungers. You meet many requirements with just a few pieces. Readily interchangeable.

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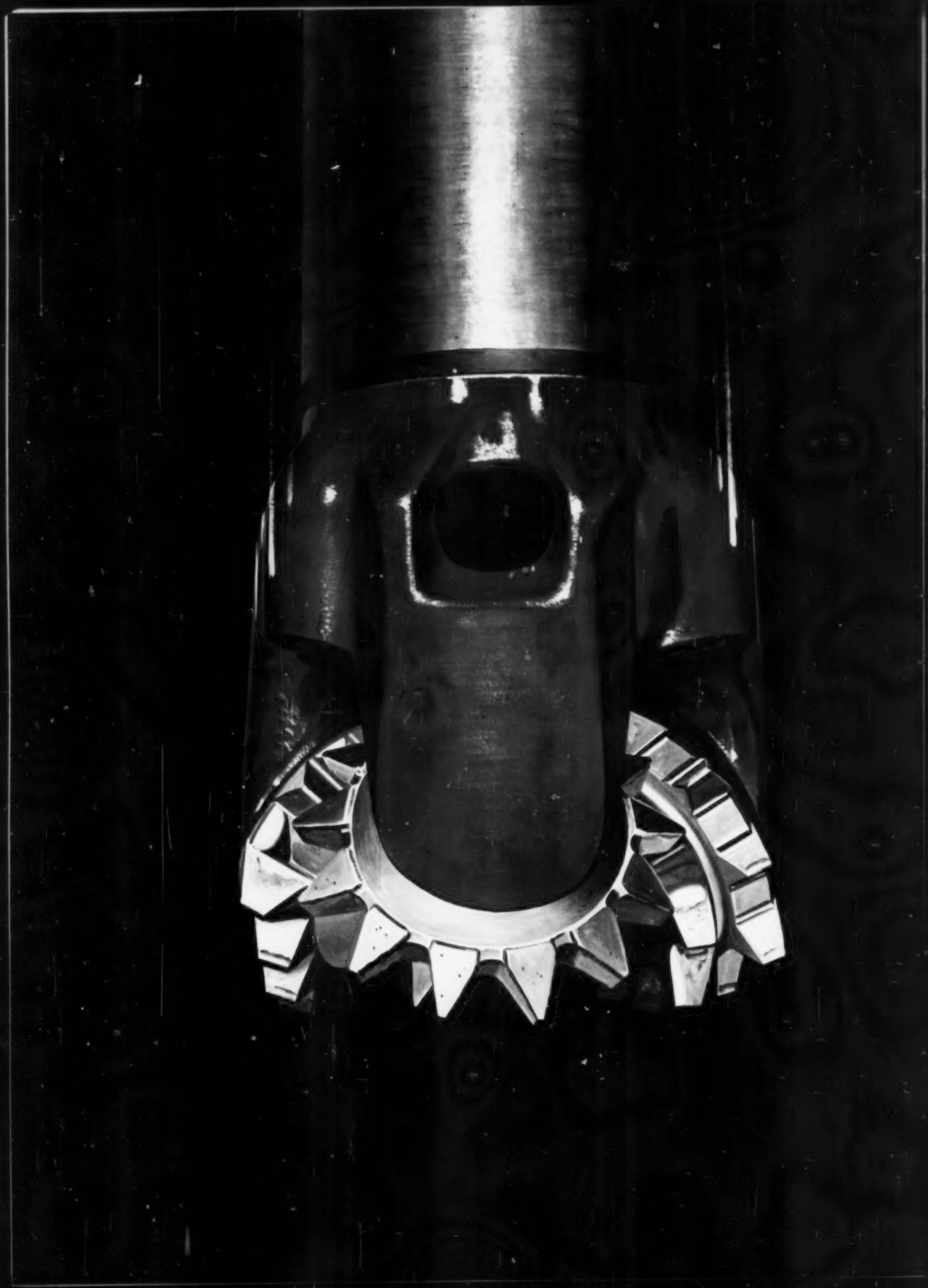

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and here's why . . .

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We now have available all the most popular sizes and types and are adding new sizes and types to our inventory as fast as possible. However, each new size and/or type requires many hundreds of hours of research, engineering, and testing. When we release a bit to the field, you can rest assured that it will dig with the best of them.

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Hardened neat cement pastes, cured under these conditions, are granulated and then exposed in vacuum desiccators to chemicals having various vapor pressures. The moisture absorbed under these conditions provides a means for determining the surface area of the hardened paste.

This is another research procedure developed at our laboratories to investigate the properties of Unaflo cement under deep-well conditions.

For more information on Unaflo retarded oil-well cement, write Universal Atlas, 100 Park Avenue, New York 17, N. Y.

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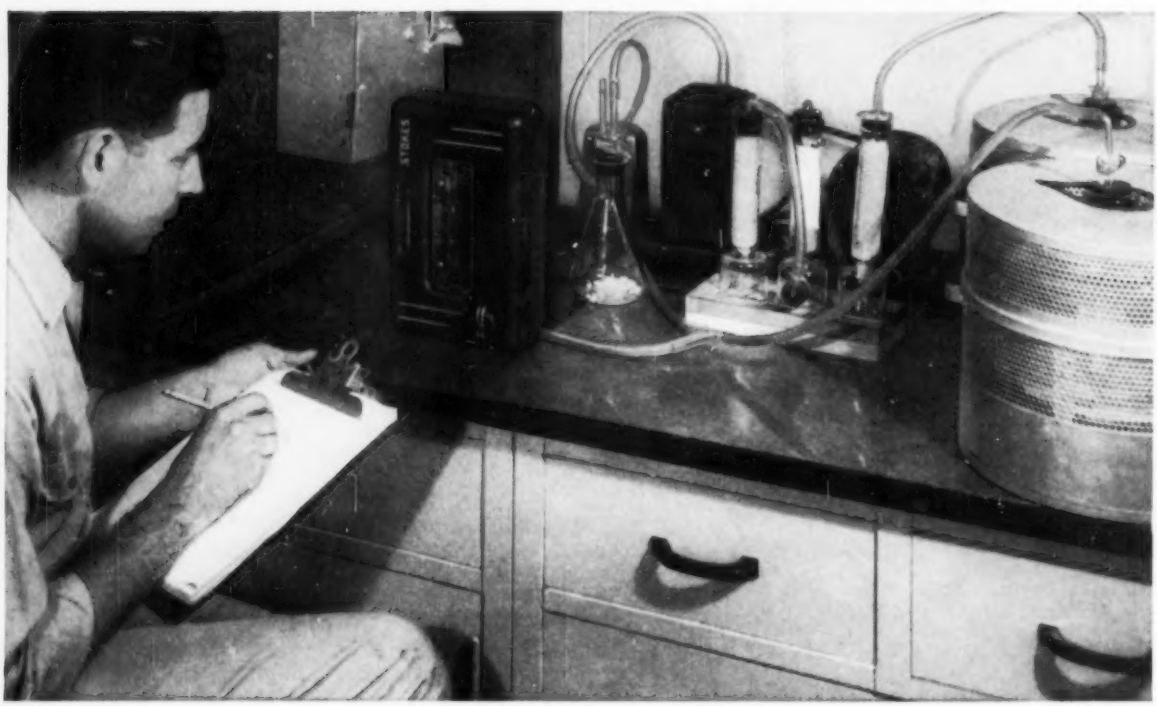

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UTAH

Pure Oil Completes Large Gas Discovery

The Pure Oil Company has announced a "substantial" natural gas discovery in San Juan County. The company's Northwest Lisbon No. 1 well on federal land gaged at rates of 5 million, 17 million, and 14 million cu ft of gas a day on three successive drill-stem tests of the Mississippian limestone from 7543 to 7774 ft. An additional 55 ft similar in character to the 231 ft already tested has been drilled.

The discovery is about 55 miles north of the Aneth field in the Four Corners area. A cross-country gas transmission line running from New Mexico to Seattle passes within 3 miles of the well which is in Section 10, T30s, R24e, San Juan County.

FLORIDA

Prospect Will Test Offshore Florida

Coastal Caribbean Oils has announced that The California Company has begun drilling operations 1½ miles off the coast of Franklin County in Gulf of Mexico tideland waters on state leases held by a Coastal Caribbean subsidiary, Coastal Petroleum Company. The well is the first to test the oil-producing possibilities of offshore areas along the coast of northwestern Florida.

Scheduled to probe to a depth of 7000 ft, the well will test a seismic structure in St. George's Sound about 11 miles east of Apalachicola. It will seek production in sands which produce oil in nearby Alabama and Mississippi.

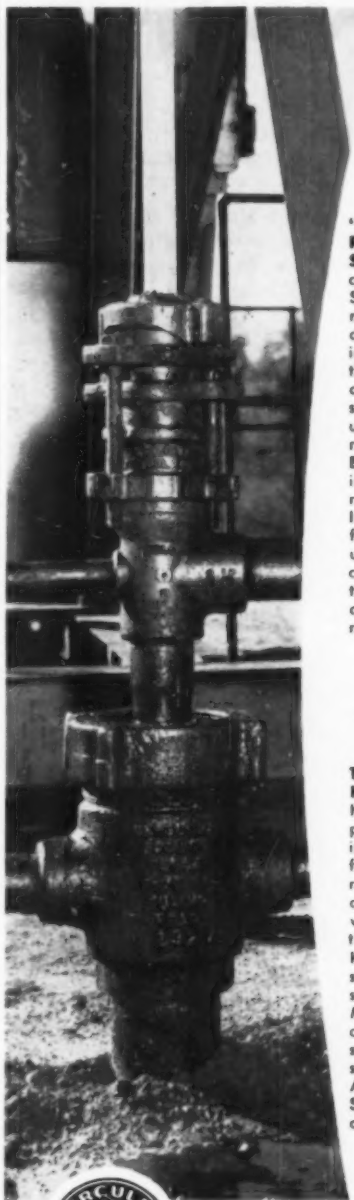
CANADA

Large Anticline Found In Caribou Mountains

The location of an anticlinal structure 40 miles in length and 15 miles in width has been reported in the Caribou Mountains properties of Crusade Petroleum, where a surface survey is presently being completed. The company reports that drilling in the entire area will be relatively shallow with the granite lying at 5500 ft. Drilling will start as soon as initial findings which indicate good prospects for oil and gas discoveries are confirmed.

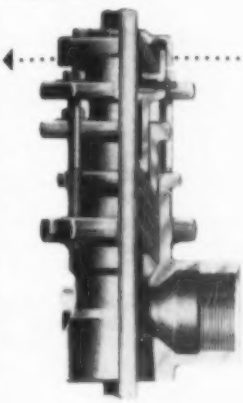
Don't miss the full story on exploration in Libya beginning on page E-1. Additional exploration news begins on page B-22.

HERCULES products in ACTION

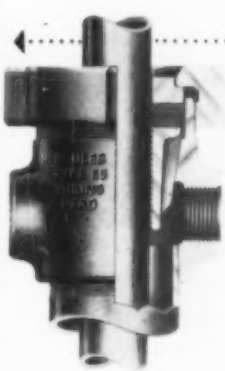


A typical set-up is shown below in Creek County, Oklahoma, using Hercules "Tee Type" Duplex Polished Rod Stuffing Box and Type "E5" Tubing Head. This is an easily assembled, effective and economical producing unit.

"TEE TYPE" DUPLEX POLISHED ROD STUFFING BOX—A combination Tee and Stuffing Box with female thread to screw directly onto the tubing, eliminating one threaded connection and resulting in a considerably shorter hook-up. With internal parts removed, the Stuffing Box body is full opening and need not be removed to pull rods. In addition to being furnished in the most used sizes, special combinations of threads and outlets can be furnished on request.



TYPE "E5" TUBING HEAD—This Tubing Head is ideal for any pumping situation. It is economical enough for shallow wells and rugged enough for any depth well, with working pressure up to 1500 pounds. Hercules self-aligning slips suspend the inner string in this Head. Mandrel suspension can be furnished instead of slips, if desired, at no extra cost. A neoprene Tubing Stripper Unit is also available.



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What's doing in DRILLING

First Drilling Test In Puerto Rico Planned

Plans for drilling Puerto Rico's first oil or gas test have been announced by David L. Gordon, independent Houston oil man, and Kewanee International Oil Company division of Kewanee Oil Company, Philadelphia and Tulsa.

A Kewanee rig from Cuba will dig a 7000 ft wildcat in the general vicinity of Santa Isabel, near the city of Ponce in Puerto Rico. It is in the south-central part of a rectangular 200,000 acre part-island, part-tidelands concession.

The wildcat's exact location has not been selected, but it will probably be designated the Kewanee-Gordon No. 1 Commonwealth of Puerto Rico, Gordon said.

Initial test will drill either to 7000 ft or to basement rock. Plans for additional drilling will depend on the outcome of the first venture, Gordon said, but "the cost of moving into a new area makes it unlikely that any operator would settle for only one try."

A portion of the geophysical work on the concession has been completed. It is one of several held by U.S. firms and individuals in the commonwealth.

Drilling in Puerto Rico should have "all the advantages of foreign operations and none of the drawbacks," Gordon said, "since it is a U.S. territory."

Campbell Named Manager For Philippine Exploration

Glenn A. Campbell has been named general manager of drilling and production for White Eagle Overseas Oil Company, Manila, Philippines. He will leave shortly to supervise the beginning of an exploration program. He is a veteran Tulsa, Oklahoma, drilling contractor and oil operator.

White Eagle Overseas holds concessions on approximately 770,000 acres in five areas of the Philippines. The drilling program will begin with a series of core holes and stratigraphic tests in northwest Leyte. Then the rig will be moved to the Camote Islands and the Bondoc peninsula of Luzon Island.

A rig has been contracted from Shamrock Drilling Company, Manila, for drilling the tests.

Campbell has been an active drilling contractor and operator in the Mid-Continent and Gulf Coast areas for 30 years. He was a founder of the American Association of Oilwell Drilling Contractors, of which he is now a director.

International Drilling Moves Offices, Personnel

International Drilling Company N. V., has changed personnel assignments and established new offices.

Wallace W. March, managing director and co-owner, has established headquarters at 50 Eastbourne Terrace in London, England. Monty R. Garrison, another director, and an engineering group and staff will remain at the company's office at Via Sallustiana 26, Rome.

O. D. Blankenship, vice president of operations, and his staff have been transferred from Rome, Italy, to The Hague, Holland. J. Walters, C. L. Bushager, and Jess Slater were also assigned there.

B. G. Frazier, vice president of engineering, and his staff have been transferred to Tripoli, Libya. Included in this assignment were drilling engineers G. W. Huff and Mario Severini.

H. R. Stephen has been transferred from Nigeria, where he served as manager for IDC to Libya to take over all IDC operations in that country. He has been promoted to vice president.

O. J. Johnson, formerly drilling superintendent, has been promoted to manager of operations in Nigeria.

W. H. Dowling, formerly general manager of British Petroleum in London, has joined the company in Rome.

Exclusive Drilling Rights Granted For Ireland

Exclusive oil and exploration rights in Ireland for the next five years have been granted the American-owned Ambassador Irish Oil Company.

The company will be obliged to spend at least $300,000 on exploration and sink at least one well to a depth of 5000 ft during the first three years, John Lynch, Industry Minister, announced.

The company is a wholly-owned subsidiary of the Ambassador Oil Corporation of Fort Worth, Texas. Ambassador will have an option, subject to fulfillment of its obligations, of a further five-year contract with 75 percent rights.

Lynch said the competition for oil prospecting rights in Ireland indicated the prospects were considered encouraging.

Bowman Elected To Post With AADOC Chapter

Gene Bowman has been elected vice chairman for programs of the Central Oklahoma Chapter of American Association of Oilwell Drilling Contractors for 1960.

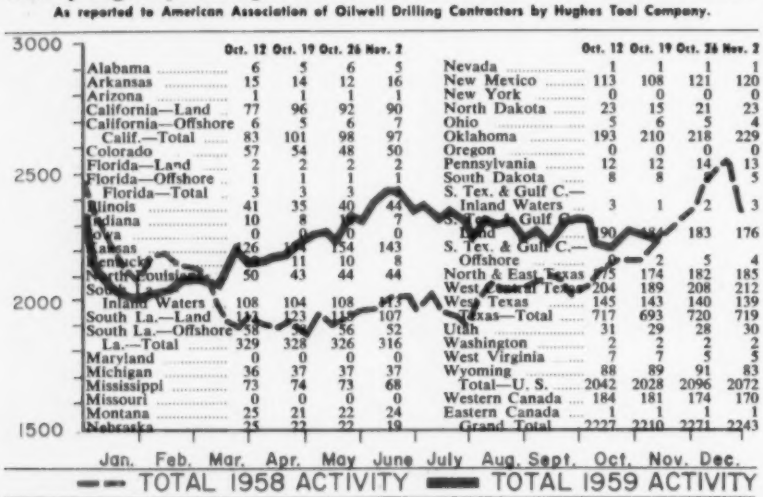
Bowman is contract representative for Big Chief Drilling Company, Oklahoma City, Oklahoma.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

	Oct. 12	Oct. 19	Oct. 26	Nov. 2
Alabama	6	5	6	5
Arkansas	15	14	12	16
Arizona	1	1	1	1
California—Land	77	96	92	90
California—Offshore	6	5	6	7
Calif.—Total	83	101	98	97
Colorado	57	54	48	50
Florida—Land	2	2	2	2
Florida—Offshore	1	1	1	1
Florida—Total	3	3	3	3
Illinois	41	35	40	44
Indiana	10	8	10	7
Iowa	0	0	0	0
Kansas	126	131	154	143
Kentucky	8	11	10	8
North Louisiana	50	43	44	44
South Louisiana				
Inland Waters	108	104	108	113
South La.—Land	123	123	115	107
South La.—Offshore	58	56	56	52
La.—Total	329	328	326	316
Maryland	0	0	0	0
Michigan	36	37	37	37
Mississippi	73	74	73	68
Missouri	0	0	0	0
Montana	25	21	22	24
Nebraska	25	22	22	19

	Oct. 12	Oct. 19	Oct. 26	Nov. 2
Nevada	1	1	1	1
New Mexico	113	108	121	120
New York	0	0	0	0
North Dakota	23	15	21	23
Ohio	5	6	5	4
Oklahoma	193	210	218	229
Oregon	0	0	0	0
Pennsylvania	12	12	14	13
South Dakota	8	8		5
S. Tex. & Gulf C.—				
Inland Waters	3	1	2	3
S. Tex. & Gulf C.—				
Land	190	184	183	176
S. Tex. & Gulf C.—				
Offshore	0	2	5	4
North & East Texas	175	174	182	185
West Coast of Texas	204	189	208	212
West Texas	145	143	140	139
Texas—Total	717	693	720	719
Utah	31	29	28	30
Washington	2	2	2	2
West Virginia	7	7	5	5
Wyoming	88	89	91	83
Total—U. S.	2042	2028	2096	2072
Western Canada	184	181	174	170
Eastern Canada	1	1	1	1
Grand Total	2227	2210	2271	2243



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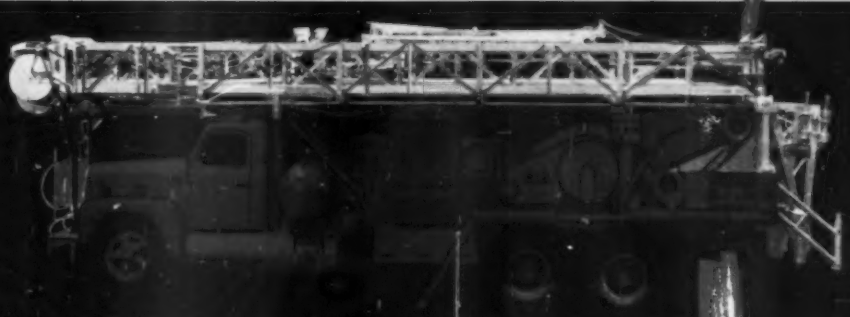

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Offshore Developments Show Growing Activity

Several events of consequence and interest have developed offshore recently. The first test is being drilled in coastal waters of Northeastern Florida, the first commercial well has been completed in the Outer Continental Shelf off Texas, a mobile drilling platform will drill a series of wells in Mexican waters, a large new mobile unit will drill its initial well after nearly a year spent dockside, and a major offshore production group expects to make a profit over the full year for the first time.

The California Company has begun drilling operations 1½ miles off the coast of Franklin County in Gulf of Mexico tideland waters on state leases held by a Coastal Caribbean subsidiary, Coastal Petroleum Company.

The well is the first to test oil producing possibilities of offshore areas along the coast of northwestern Florida.

It is being drilled by the Standard Oil Company of California subsidiary under the terms of a 1955 agreement with Coastal for exploration and development of approximately 4,500,000 acres of state leases on Florida's west coast.

Scheduled to drill to a depth of 7000 ft, the well will test a seismic structure in St. George's Sound about 11 miles east of Apalachicola.

In another area, Standard Oil Company of Texas announced completion of what it termed "the first commercial oil well in the Outer Continental Shelf off Texas." The company was first to complete a commercial oil discovery in the Texas tidelands closer to shore.

Standard's Federal 52, No. 2, had opened an oil pool in the Gulf of Mexico's High Island area about 36 miles northeast of Galveston.

The giant mobile drilling platform Vinegarroon, owned by Zapata Offshore Company of Houston, will drill 10 or more wells in the Bay of Campeche, about 100 miles southeast of Veracruz near Coatzacoalcos.

Operations will be carried out in 70 to 100-ft water depths, three or four miles offshore, George Bush, Zapata president stated.

Tests will be drilled to "around 10,000 ft," and will mark the first use of the unit in foreign waters.

There are three oil producers in the general region at present.

Pauley Pan American Petroleum Corporation has teamed with Petroleos Mexicanos, government oil company, in exploration and development of the area.

For the first time, the giant new drilling barge Mr. Louie will commence drilling. Owned by Universal Drilling Company, the long-idle $5 million barge has been leased by Reading & Bates Offshore Drilling Company, Tulsa, and will spud a well off Louisiana for Tennessee Gas Transmission Company.

A six-year lease with an option to buy was taken on the barge, and considerable work has been secured in the Louisiana offshore area.

The barge has remained idle since it was commissioned last February.

In another development, the CATC offshore group has announced that it expects to realize a profit over the full year for the first time in 1959.

Economizing with multiple completions was given credit for much of the success. Of the 156 offshore wells with a total of 277 strings of tubing that CATC had on July 1, only 74 were single completion—the remainder were duals, triples, and quadruples.

The group now has seven quadruple completions, and some wells have found up to 18 sands which had oil or gas.

Drilling Firm Moves Offices in California

Gene Reid Drilling, Inc., a subsidiary of Occidental Petroleum Corporation, has moved to a new location in Bakersfield, California, Dr. Armand Hammer, Occidental president, announced.

The firm, which was absorbed by Occidental only recently, took over the former facilities of the Kern County Land and Water Company of 5000 Stockdale Highway. Former address was 4101 Pierce Road.

Occidental's field, geological, and exploration offices have been combined with those of Gene Reid Drilling. Main office for the entire company, including the Reid firm, is at Occidental Petroleum's headquarters, 8255 Beverly Boulevard, Los Angeles.

Two New Helicopters Delivered to PEMEX

Petroleos Mexicanos has purchased its first two three-place helicopters to augment its fleet of fixed-wing aircraft.

The two new helicopters were flown from the United States to Mexico by Capt. Luis Salina, PEMEX chief pilot, and Capt. Alberto Gayon. Both recently completed helicopter training, although they are experienced in flying fixed-wing aircraft.

PEMEX will use the helicopters to transport personnel and supplies to offshore oil rigs operating off the east coast of Mexico. They will also be used in inland areas for oil and gas exploration, survey, and patrolling the country's growing system of pipelines.

Voges Named AOSC Assistant

WALTER W. VOGES has been named by the Board of Directors of the Association of Oilwell Servicing Contractors to serve as assistant to the executive secretary of the organization, Jim Danheim, effective October 13. Voges, former fieldman with the Texas Pharmaceutical Association, has filled the vacancy created by the July resignation of James A. Gobel, Jr. Upon taking over his new duties, Voges (pronounced Vo-gus) announced his intention of increasing local chapter participation throughout the AOSC.

Voges is a life-long resident of Austin, Texas, having moved to that city from his Lockhart, Texas, birthplace when only one year old. His elementary and high school education

Walter W. Voges

was acquired in Austin, and he is a graduate of Austin High School.

While in grammar school and junior high school, he was a page in the Texas House of Representatives, and while still in high school, was a member of the Texas National Guard.

At 16, he began a 2½-year tour of duty with the United States Navy, which was at that time engaged in the Pacific Theater in the war against the Japanese. He served 18 months with the Pacific Fleet in the Asiatic, Pacific, and Chinese Theaters, and in the American Area of Operations. He was honorably discharged upon completion of his tour of duty.

Voges returned from the services and entered Southwestern University in Georgetown, Texas, to study for the Methodist ministry. During this period, he was active in the ministry and served in several churches as an accepted supply minister. Unable to complete his ministerial education because of a serious illness and the resulting financial pressures, he found it necessary to enter a new field and went into the insurance business as an agent.

He rose from agent to district manager for an insurance company in three years. It was while acting as district manager that Vogus first became interested in association work and when the opportunity presented itself, he went to work as field assistant to Max Roesch, executive secretary of the Texas Pharmaceutical Association, where he was employed at the time of his selection by the board of directors of AOSC.

"The AOSC expresses its appreciation to Mr. Roesch and his association for permitting Walter to come with us without more notice, and AOSC hereby expresses its thanks to him," said J. C. Williams, Jr., president of AOSC.

Executive secretary Jim Danheim has expressed confidence in Voges' ability and said that in addition to his personal knowledge of Voges in the past seven year, his training and past experience assures the AOSC of getting a top man. ★ ★ ★

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RUNNING TOUR with MEN in the INDUSTRY

J. R. MacGregor has been named a vice president and director of the California Research Corporation. In his new capacity, MacGregor will be in charge of petroleum products research. He succeeds **J. L. Cooley,** who retired recently after nearly 40 years' service.

Two personnel transfers in the exploration department of Tennessee Gas and Oil Company, a division of Tennessee Gas Transmission Company are **L. L. Parish,** district exploration superintendent, transferred from Roswell, New Mexico, to Oklahoma City and **Eugene McElvaney Jr.,** district exploration superintendent at New Orleans, transferred to replace Parish, who succeeds **James D. Giles,** resigned.

Jed B. Maebius has been named manager of the exploration department of Tidewater Oil Company's Southern division at Houston, replacing **T. G. Kelliher** who was recently elevated to exploration manager for domestic operations in the company's Los Angeles headquarters.

W. H. Hammond has joined Texstar Petroleum Company, a division of The Texstar Corporation, as petroleum geologist and manager of exploration activities. He spent 18 years with Magnolia Petroleum Company and 11 years with Ralph E. Fair, Inc., where he was vice president, prior to joining Texstar Petroleum.

Joseph A. Kornfeld, manager of Kornfeld International, a new consulting firm offering geological, geophysical, economics and engineering services on foreign oil concessions. Principal offices are in the Mid-Continent Building, Tulsa, Oklahoma, with auxiliary offices to be opened in Denver, New York City, and London, England.

J. A. Kornfeld

Wayne M. Dowden has been appointed a research engineer in Continental Oil Company's production research division. He has served with Shell Oil Company at Houston, Texas, as a refinery technologist and with Ohio Oil Company at Littleton, Colo., as a research engineer. He also has served both as a graduate assistant and as a research fellow at Purdue University, Lafayette, Ind.

W. M. Dowden

T. N. Law Jr.

T. N. Law Jr., exploration and landman, has been appointed vice president in charge of intercompany and public relations for Falcon Seaboard Drilling Co. of Tulsa. He will continue his duties with the exploration department but will be in charge of an expanded internal and public relations program for the company.

Robert L. Hoss, Denver, Colorado, has established an office in the Denver Club Building as a petroleum consultant. For the past 5 years Hoss has been associated with Vaughey & Vaughey, Denver, as director of drilling and production operations in the Rocky Mountains and Canada. He also handled the company's recently completed water pipeline system.

R. L. Hoss

Dr. B. N. Rolfe

Dr. Bernard N. Rolfe, formerly with the United States Geological Survey and a consultant on waterflood recovery, has joined Sinclair Research Laboratories, Inc., as assistant director of the exploration research division. He is assistant to **James F. Johnson,** director of the exploration research division for Sinclair Research.

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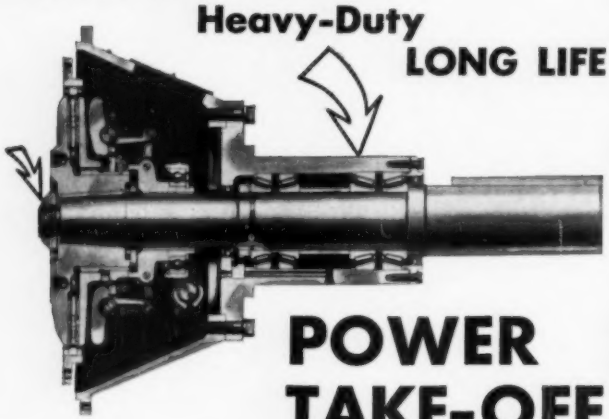

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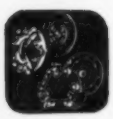

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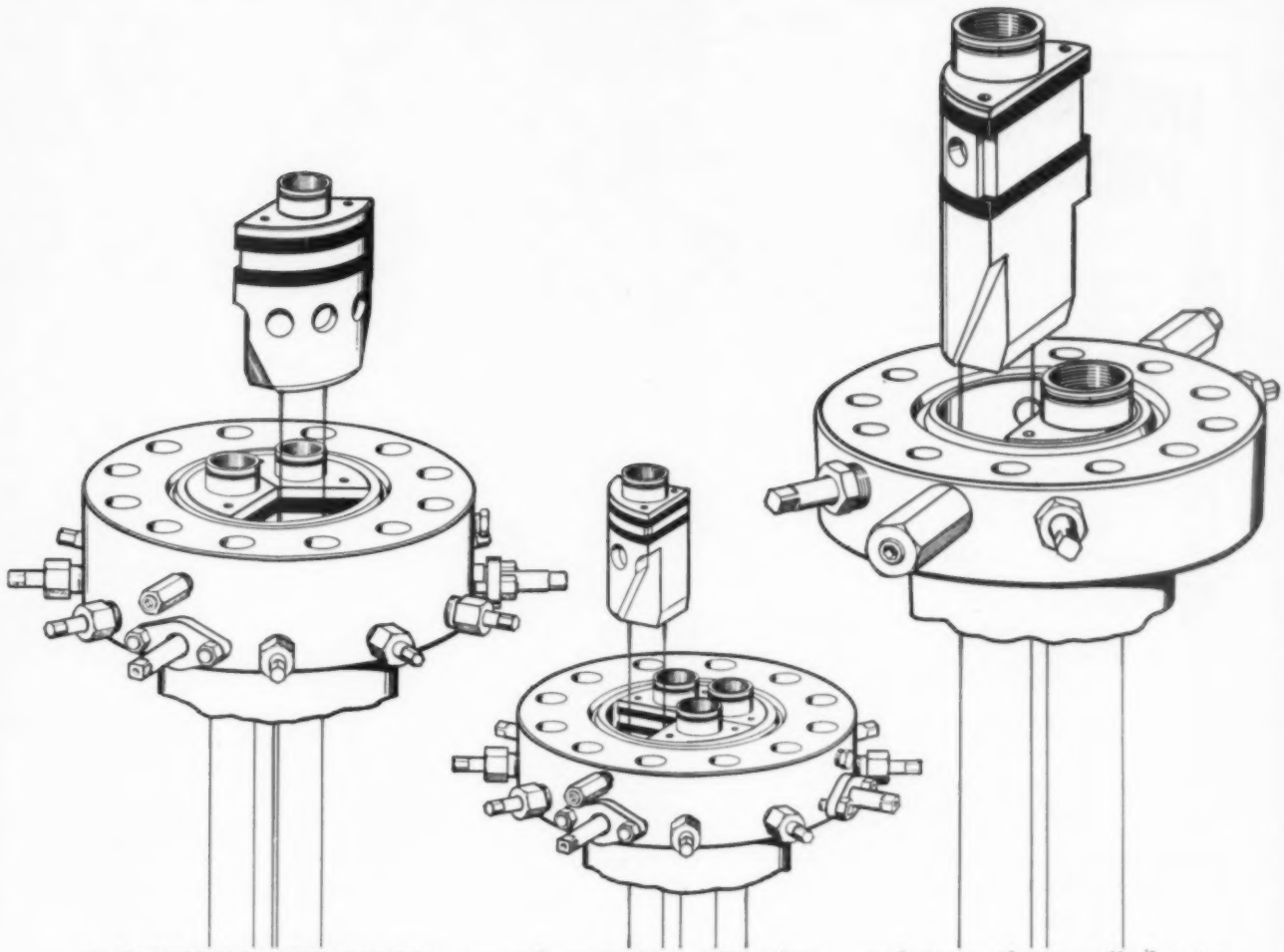

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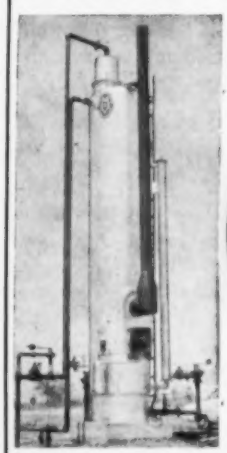

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Running Tour

▸ **W. W. Clawson** of Dallas, senior vice president and director in charge of exploration, producing and research activities, Magnolia Petroleum Company, has been named manager of exploration for Mobil Oil Company. Mobil Oil is the operating division of Socony Mobil Oil Company, Inc., for the U. S. and Canada. It has absorbed Magnolia's operations as part of a nationwide reorganization involving Socony Mobil's former domestic affiliates.

W. W. Clawson

In the Houston division of Mobil's exploration and producing department **H. H. Beeson,** formerly manager of the natural gas department for Magnolia Petroleum in Dallas, becomes division natural gas manager of the Houston division. **K. F. Keller** is district exploration superintendent at Houston. He was formerly district geologist there. **Robey H. Clark** to district exploration superintendent with headquarters at New Orleans, formerly district geologist at New Orleans. **H. V. Lilley,** district landman at Midland, becomes district exploration superintendent with headquarters in Jackson, Mississippi. **E. J. Medley** to district exploration superintendent at Shreveport, Louisiana. He was formerly division geophysicist for Magnolia at Roswell, New Mexico. **Paul L. Plumer,** formerly district landman at Amarillo, is district exploration superintendent with headquarters at Corpus Christi.

▸ Union Oil Company of California's exploration and production departments, covering both domestic and foreign operations, announced changes following retirement of **Sam Grinsfelder** as vice president for exploration. **Basil P. Kantzer,** vice president and manager of operations for the Gulf division, becomes vice president in charge of exploration for the United States (including Alaska) and Canada, with headquarters in Los Angeles. **K. C. Vaughn,** manager of the natural gas and gasoline department, to manager of operations for Union's Gulf Division, with headquarters at Houston. **J. R. Fraser,** assistant to Vaughn, will replace him with headquarters in Los Angeles. **E. C. Babson,** manager of operations for the Canadian division, will be transferred to California headquarters as manager of foreign operations.

E. W. Scott, staff geological coordinator, replaces Babson, headquartering in Calgary. **E. R. Atwill,** manager of operations for the West Texas division, transferred to California for special assignment to the exploration department staff. **Ray A. Burke,** chief geologist for the Gulf division, replaces Atwill, with headquarters at Midland, Texas.

▸ **W. J. McBride,** formerly geologist with Humble Oil & Refining Company, Wichita Falls, Texas, has joined D. R. McCord and Associates, consultants, Meadows Building, Dallas, Texas, to take charge of domestic geological evaluations.

▸ **Harris Van Zandt** has been appointed general manager of the Pure Oil Company's exploration and production division. His headquarters will be in Chicago. For the last 5 years Van Zandt has been manager of Pure's Rocky Mountain producing activities with headquarters first in Billings, Mont., and later in Denver. **Ira Needham Jr.,** was named acting manager of the Rocky Mountain producing division. Needham served the Rocky Mountain division as its chief accountant and office manager from 1945, until August of this year when he was transferred to the company's offices in Chicago on a special assignment.

▸ **G. D. (Dan) Almen Jr.,** vice president and manager of the Midland, Texas, division of Sinclair Oil & Gas Company, has been transferred to the offices of Sinclair Oil Corporation in New York City, where he will help direct the corporation's world-wide exploration and production activities. Almen will assist **Fred A. Bush,** vice president and a director of Sinclair Oil & Gas Company and a vice president of Sinclair Oil Corporation. **Robert L. Elston,** assistant manager of the Midland division, has been elected vice president and Midland division manager to succeed Almen.

G. D. Almen, Jr.

R. L. Elston

▸ **S. A. Berthiaume,** who was an executive of Texaco Exploration Company, has been appointed manager of the newly-created exploration division, Domestic Producing Department of Texaco Inc. Berthiaume will headquarter in Houston.

Also in the Domestic Producing Department **J. W. Rawley,** assistant general manager, Houston, is the new division manager of Tulsa division. He succeeds **H. O. Woodruff,** who was transferred to a new assignment. **L. W. Calahan,** assistant division manager of New Orleans division, named division manager of Dallas division. **O. F. Sebesta,** assistant division manager of Midland, Texas, division, was promoted to assistant general manager of the department and will have headquarters at Houston. **L. F. Shiplet,** former division manager of Dallas division, is transferred to Houston as assistant to the general manager and **G. H. Clark,** assistant division manager of Houston division, also has been made assistant to general manager.

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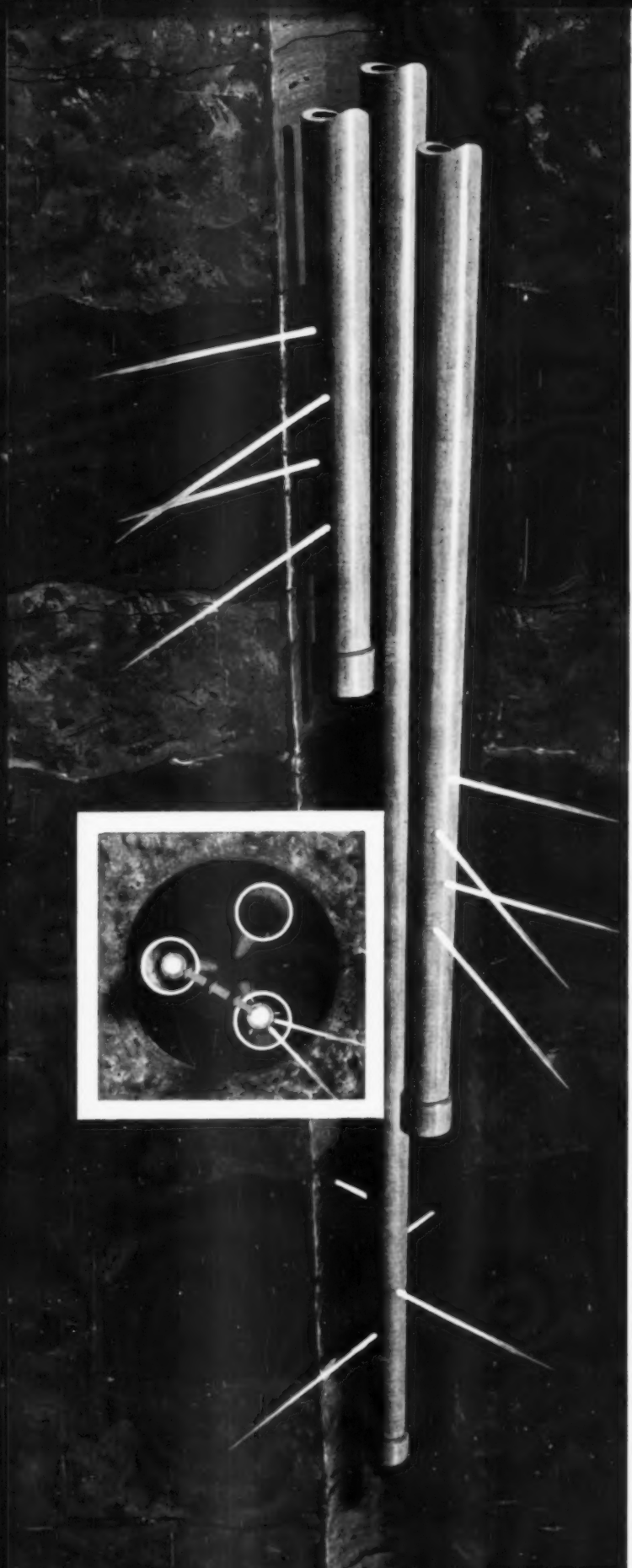

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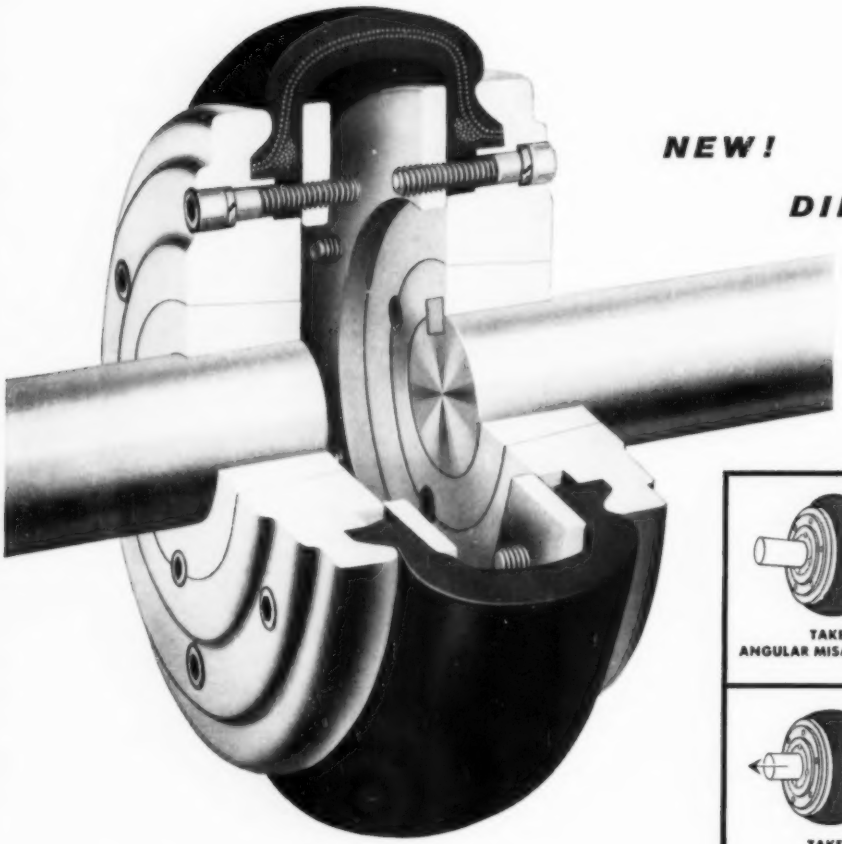

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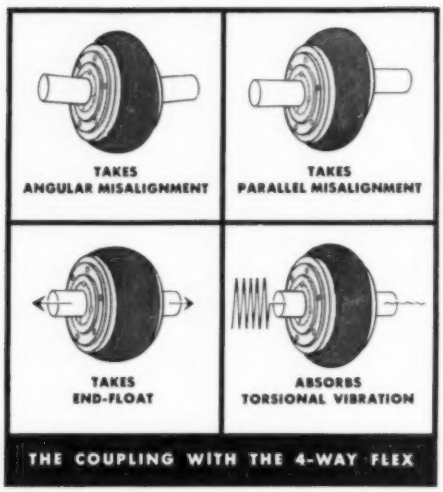

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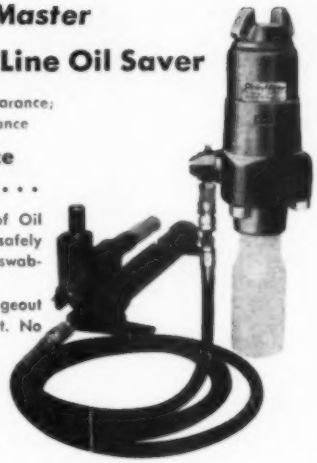

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Running Tour

J. R. Spencer

F. B. Willson

John R. Spencer, Houston, has been promoted to director of natural gas activities for Continental Oil Company's production department. Formerly engineering section chief in the production department, he will continue in Houston and succeed **J. W. Ferguson,** recently promoted general manager of the intrastate gas and gas products department.

F. B. Willson, Houston, coordinator of natural gas sales since 1956, has been promoted to assistant director of natural gas activities and **B. L. Waggoner,** Oklahoma City, division engineer, has been named to succeed Spencer. Both men also will headquarter in Houston.

R. M. (Bob) Borden has joined Peter Bawden Drilling Ltd., and will be located in Edmonton, to coordinate the office and staff work with the drilling department. In this capacity Borden will work with **Swede Black** and field superintendents, **Lloyd Dease, Hank Zutz** and **Tony Vanden Brink.**

Jake Blevins was named chairman of the committee to "Study Effects of Oil Imports on State Oil Conservation Programs," Interstate Oil Compact Commission, by **Gov. J. Hugo Aronson,** of Montana, chairman. Bevins succeeds **W. A. Delaney Jr.,** who resigned.

E. J. Davis Jr., was named by **Gov. J. Howard Edmondson,** Oklahoma, as his representative on the Commission succeeding **Wayne Beard,** resigned.

R. T. Cox, manager of The Atlantic Refining Company's Rocky Mountain region, will succeed **Niles B. Winter** as manager of the West Texas-New Mexico region when the latter retires in May 1960. **A. B. Macaulay,** manager of the company's Oklahoma-Kansas region, will succeed Cox at that time.

Fred Giari has been appointed training supervisor for Tidewater Oil Company's western division. Prior to joining Tidewater, Giari was training director of the Southern California Gas Company.

NOMADS MEETING DATES AND SECRETARIES

New York Chapter, first Monday of the month, Hotel Roosevelt, New York. Executive Secretary, E. W. Hoeppner, in care of Hughes Tool Co., Room 903, 45 Rockefeller Plaza, New York 20, N.Y.

Houston Chapter, second Monday, Ye Old College Inn, Houston, Texas. Executive Secretary, Harry E. Estes, P. O. Box 18171, Houston 23, Texas.

Los Angeles Chapter, second Wednesday, Michaels Restaurant, Los Angeles, California. Executive Secretary, W. A. Sawdon, P. O. Box 848, Hollywood 28, Calif.

Tulsa Chapter, third Friday, Mayo Hotel. Executive Secretary, E. L. Thomas, P. O. Box 3771, Tulsa 9, Okla.

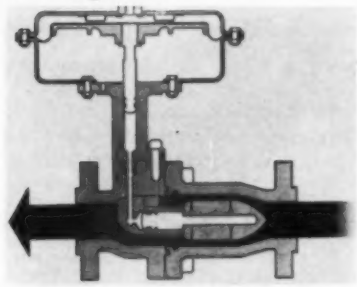
Dallas-Fort Worth Chapter, first or second Monday. Secretary, R. B. Gilmore, DeGolyer & MacNaughton, 5625 Daniels, Dallas, Tex.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

It's New

Drilling – Producing Equipment

Laminar Flow Gas Regulator



A new gas regulator for reducing pressure features straight-through or laminar flow and positive shutoff. The Jet Stream regulator developed by APCO Division of Texcron, Inc. has a resemblance to a jet engine in design and streamlined flow of gas around the unit.

The regulator's straight-through flow eliminates jetting of high-speed gas and transient particles into the side of the regulator. The smooth, straight-through flow also reduces sound vibration.

A hydraulically actuated slave piston regulates flow with extremely fine control. The unit can be regulated from full-flow to bubble-tight shut-off in 3 seconds.

Regulator is an expansion type, pneumatic-hydraulic operated regulator, and incorporates conventional controls. A diaphragm motor is the actuating power source, and the diaphragm plate is connected to a master hydraulic piston which operates a slave piston within the regulator body.

Flow through the regulator is controlled by compression of a solid rubber cylinder when the slave position acts against a movable slotted baffle. Increasing or decreasing the annular area between the rubber cylinder and the interior regulator body controls flow.

Regulator can be used for controlling back pressure and down-stream pressure; for flow control; as a dump valve; and as a manually-operated valve. *APCO Division of Texcron, Inc.*

Circle number (1) on reply card.

Production Manifold Three-Way Valve

A new 3-way valve, the Many-Flo, was designed by National Tank Company primarily for use on lease well production manifolds.

The valve may be used for mixing 2 different liquids or gases, and as a switching valve to divert flow to different tanks or lines.

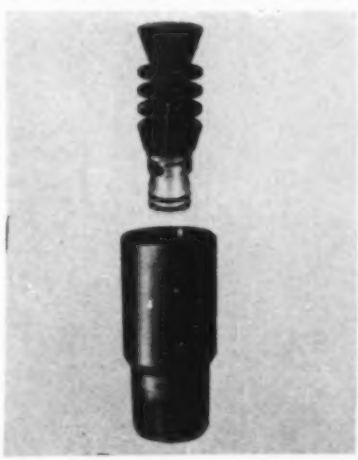
Control in any application can be hydraulic, electrical or diaphragm, and it can be sensed by liquid levels, pressure, temperature, times or differentials of these. They can be installed in a horizontal line with diaphragms and valves either vertically or horizontally.

The valves have a working pressure of 600 psi, and are available in 6 basic models. *National Tank Company.*

Circle number (2) on reply card.

Tubingless Completion Plug, Collar

A new tubing wiper plug and landing collar assembly for use in tubingless completion has been developed by Texas Iron Works.



The assembly is designed to insure the operator against faulty cementing jobs. The landing collar is placed in the tubing at a point where pressure seal is desired. After cement has been pumped into tubing, the wiper plug is placed in tubing and pumped down until it latches into the landing collar.

The devices have been thoroughly field tested in numerous tubingless completion wells. *Texas Iron Works.*

Circle number (3) on reply card.

Directional Perforator Uses Nuclear Scanning

An entirely new approach to directional perforating for multiple string, tubingless completions is a combination tool to locate collars, position the perforator in the zone of interest, orient the gun away from the other strings of casing, and perforate the desired zone all on one run in one string of casing.

The Directional Perforator developed by Lane Wells Company consists of a collar locator, a nuclear orientor, a rotator, and a perforator. It is run by a standard perforating-logging unit on a standard conductor line, and a surface recorder records the location of collars and the location of other casing strings.

The collar locator picks collars on the trip into the well. When the zone of interest is reached, the nuclear orientor scans the zone to locate the position of the other casing strings. The other casing strings are not disturbed.

This scanning by stages operation is done by raising or lowering the tool, and it is continued for 2 complete revolutions to positively locate the other casing. Then the perforator is positioned away from other casing, checked again with the orientor, and fired. *Lane Wells Company.*

Circle number (4) on reply card.

Lubricated Plug Valves With Flanged Ends

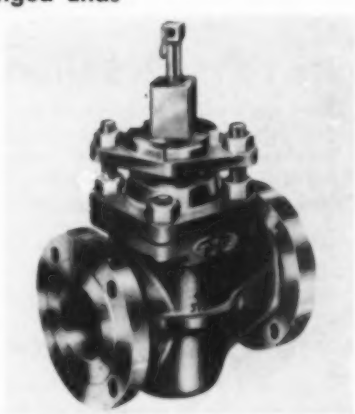
A new series of cast steel and iron lubricated plug valves with flanged ends has been developed by Triangle Valve.

The steel valves flanged to ASA 150 are available in 1½, 2, 3, 4 and 6 in. sizes.

The body, cover, gland, and stop are cast carbon steel. A cast iron, heavy duty plug meets a steel lantern ring. Other features are rubberized cotton fabric packing, asbestos fiber gasket, diaphragm in stainless steel, and grease plugs that are interchangeable with many other makes.

The cast iron lubricated plug valves are standard type, short pattern, with cast iron body plug and cover. Ends are flanged and drilled to ASA class 125 and it is suitable for wrench operation and lubrication.

The valves are lubricated by clockwise rotation of the grease screw, which forces the lubricant into the system, where it is initially directed to the lower chamber on the underside of the plug. When pressure builds up in the lower chamber, it forces the plug upward, away from its seating and against the resilient gland packing. This lubricates the rotating faces of the plug. *Triangle Valve Company, Ltd.*

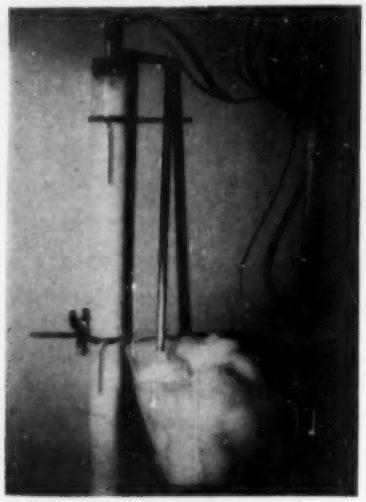


Circle number (5) on reply card.

New Equipment

Foaming Agent, Water Absorbent

A new foaming agent, Howco-Suds, and an improved water absorbent, Howco-



Sorb, are now available from Halliburton Oil Well Cementing Company for air and gas drilling.

The foaming agent is a water-soluble surfactant that gives a low surface tension to all types of water and is capable of producing large volumes of foam under different conditions.

The material will regain the return of balled cuttings and give continuous foaming action during drilling. In concentrated amounts it aids drowned gas wells by turning formation water into a lightweight foam which can be easily brought to the surface.

Foam aids dispersing of injection-plugging silt and clays in water injection wells by loosening and removing the solids.

The water absorbent will soak up water about 4 times its weight and will still remain a loose, free-flowing powder.

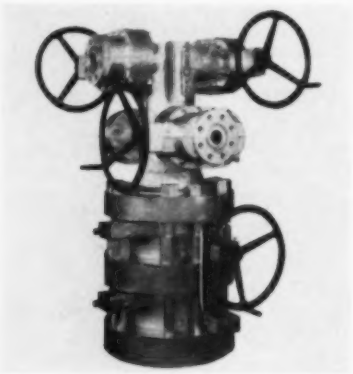
It is useful in drying wet holes after water shut-off and permits prompt resumption of dry drilling. *Halliburton Oil Well Cementing Company.*

Circle number (6) on reply card.

Compact Valve Assembly For Well Completions

A wellhead valve assembly which is less than half the size of conventional types will soon be marketed by Grove Valve and Regulator Company.

Besides its compactness, the assembly permits rearrangement of valves as characteristics of the well change. It also permits worn components to be changed in the field, as it can be assembled or disassembled in an hour or less, company engineers report.



The assembly will be available in any combination of master valves, wing valves, tees, and bores tailored to meet individual needs. Bore sizes range from 1½ through 4 in. Working pressures are 2000 to 10,000 psi. Flange connections and bore seals can be supplied to meet any specifications.

It is offered in single, dual, triple, and quadruple completion Christmas tree components. *Grove Valve and Regulator Company.*

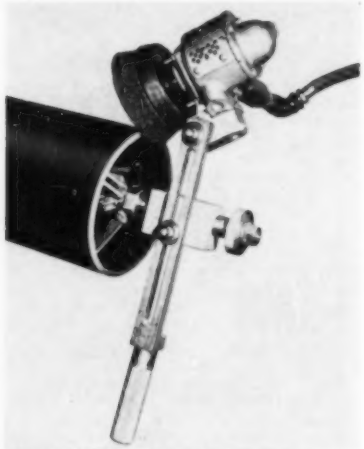
Circle number (7) on reply card.

Pipe Grinder Operates On-the-Job

The new Wachs Bev-L-Grinder is designed to make machine-shop accurate weld bevel preparation on 6 to 8 in. pipe on-the-job.

It cuts accurately without changing the physical properties of regular-grade, stainless, or high-alloy steel and aluminum pipe, the company claims.

The head can be set 20 deg, 37½ deg, and 90 deg by a locking pin in the motor support. Other angles are available by



locking the grinder head with a socket head cap screw.

Cutting action is fast, accurate, and easy to control. The operator simply rotates the grinder head around a self-centering spindle. *E. H. Wachs Company.*

Circle number (8) on reply card.

Automatic Recorder

The improved Dial-O-Graph made by Mullins Manufacturing Company supplements equipment by eliminating the necessity of being at a given chart at a specific time or day, and does not require extensive changes in present equipment.

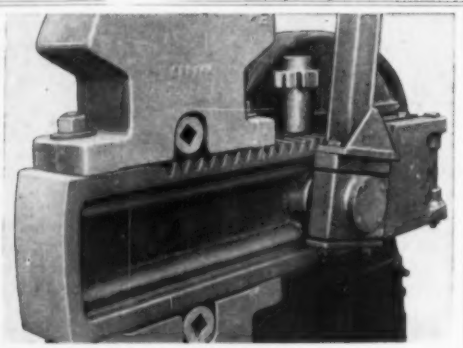
It is a simple, sturdy device combined with a universal Mac-Nick type spring driven chart drive and has its own chart plate. The device can be added to most any standard instrument which uses circular recording charts and uses the same space as standard chart drives.

The drive has a remote wind and may be used in almost any instrument. The 24-hour rotation 8-day wind; the 7-day rotation 31-day wind; and the 24-hour rotation gas or pressure drive are all the same size and shape. *Mullins Manufacturing Company.*

Circle number (9) on reply card.

. . . the smoother stroke . . . . . . gives longer life . . . with this

JENSEN



Rotary Balanced JACK!

The easy to adjust rack-and-pinion system of *JENSEN'S* Rotary Balanced *JACK* provides a smoother stroke throughout the entire pumping cycle . . . thus assuring longer, trouble-free service from the sub-surface equipment as well as the pumping unit. Uses less electric power, too!

Let us tell you more about the entire line of JENSEN Rotary Balanced JACKS — it'll pay you to investigate!

Made by **JENSEN BROS. MFG. CO., INC.**

P. O. Box 477-B, Coffeyville, Kansas

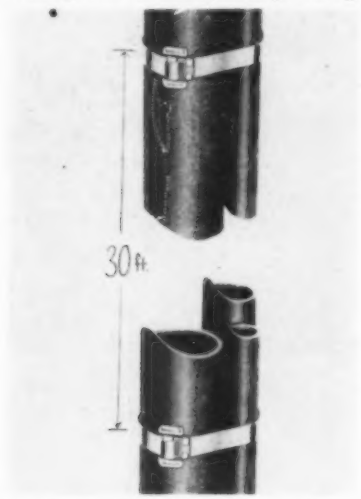
Export Office: 250 Park Avenue, New York 17, N. Y.

STOCKED BY YOUR LOCAL SUPPLY STORE

JENSEN JACKS

Band Clamping Method

Band-It, a clamping method that is new to the oil industry, is being used on rotating wall scratchers, multiple strings



of tubing, instrument cables to tubing, and many other applications.

The device uses a special buckle, a piece of ¾ in. wide stainless steel band from a dispenser carton, and a special tool for installation. Any diameter or irregular shape can be clamped quickly and economically using this method.

To secure 2 or more strings of tubing compactly where multiple strings are used, one man can perform installations at recommended 30 ft intervals. This gives a strong, rigid cluster, regardless of the number of tubes in the string.

The stainless steel clamps conform to any contour and diameter. Low profile of this type clamp on strings of multiple tubing permits smaller diameter holes and cas. r, thereby reducing the hazard of costly fishing jobs. *Band-It Company.*

Circle number (10) on reply card.

Protecting Tubing During Perforation

Comparison tests for material to be applied on the exterior of tubing for multiple completion wells in areas subject to blast from casing perforations showed that straight epoxy reinforced with glass material provided the best resistance. Eighteen materials were tested by Grigsby Bros., Inc. for suitability.

The straight epoxy was reinforced with 2 mill thick glass material, and 10 layers were used to obtain a total thickness of ¼ in. Blast duration before the material was penetrated 100 percent was 25 minutes. Results indicated that the material would double the life of tubing.

Tests were made in a standard blast cabinet using 100 lb nozzle pressure, ¼ in. nozzle size, and silica as the abrasive material. Velocity of striking sand was about 200 mph. Each material tested was about 4 in. from the nozzle and in a rigid position. *Grigsby Bros., Inc.*

Circle number (11) on reply card.

Casing Protector

Grip-Lok, economy model latch-on protector with locking pin, was recently placed on market by Byron Jackson Tools. Protector is of all-purpose synthetic rubber, bonded to a hinged steel inner cage to form a series of interlocking faces at the latching ends. The locking pin drops through the compound hinge element to hold the protector securely to the drill pipe. Grip-Loks can be installed or removed by one man in less than 10 seconds, using two simple tools — an installation tool and a pin pull-out tool. Manufacturer claims that Grip-Loks may cost less than conventional stretch-on type protectors where removal and reinstallation costs are involved. Grip-Lok Protectors are 5 in. in length; are available for all drill pipe sizes from 2⅞ in. to 5½ in. *Byron Jackson Tools, Inc.*

Circle number (12) on reply card.

Combination Logging — Perforating Units

Economy and efficiency are said to be major advantages of new combination logging-perforating units being introduced by The Western Company. The new unit, designated "Type 10," provides logging and perforating services from a single compact unit engineered for operation to depths of 10,000 ft. According to Western, the unit provides the wire line services previously performed by larger units, and when both nuclear logging and perforating are required, the Type 10 does the work of both a logging panel and hoist truck. The basic features of the larger unit — including scintillation logging instrumentation — were retained and fitted into the compact chassis. *The Western Company.*

Circle number (13) on reply card.

Remote Controlled Oil Saver

A new hydraulically operated Strip-Master wire line oil saver built by Bell Rubber Company features remote control as a safety and performance feature. Other advantages claimed are fast, easy packing changeout by unscrewing the top

nut; packing wear indicator located at the hand pump, providing convenient and positive indication of packing condition before packing is fully worn out; and a pack-off principle that assures clean, longer-wearing line stripping performance.

Unique cylindrical packing is compressed by hydraulic action all around the side, providing a tight and lasting squeezing action around the line. A swivel-type connector is designed to minimize chance of damage or breaking connection during rigging, or in operation. *Bell Rubber Company.*

Circle number (14) on reply card.

HYCALOG V-DOOR
DIAMOND DRILL BITS
PATENT PENDING
HYCALOG

INCREASES AVERAGE FT./HR. FROM 1½′ TO 5.7′ IN 7000 FT. CANADIAN WELL

In a recently completed hole in British Columbia a series of conventional rock bits averaged only from one to two feet per hour. The longest run was 31 ft. . . . the shortest 9′.

At this point a Hycalog V-Door was run. From 6709′ to 7229′, it averaged 5.7 ft./hr., a performance so unbelievable that the string was pulled to check on the bit. *Still in excellent condition,* it was rerun. The balance of the run to 7734′ was completed . . . also at an average of 5.7 ft./hr. . . . and the bit was still in good condition.

Let a Hycalog V-Door set a record on your next well. *And include* Hycalog Well Logging *and* Drill Function Recording.

Hycalog, Inc.
505 AERO DRIVE
SHREVEPORT, LOUISIANA
BRANCH OFFICES IN PRINCIPAL OIL PRODUCING AREAS
DIAMOND BITS DIAMOND CORING
WELL LOGGING CORE ANALYSIS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Drilling-Producing Literature

Oilfield Engine Specifications

Specifications for oilfield engines are given in a new book recently published. The 12-page booklet contains 5 pages of condensed specifications for all models of Caterpillar Diesel and Natural Gas Engines. Specifications are given for hoisting, pumping and drilling duty as well as engine-converter, marine and electric set data. *Engine Division, Caterpillar Tractor Company.*

Circle number (15) on reply card.

Electric Generator Catalog

Recently-added line of high-capacity electric generating plants is described and illustrated in a new 1960 general catalog F-146.

Catalog F-146 is a 2-color, 8-page folder listing more than 45 basic models of Onan gasoline and diesel engine-driven generator sets. Each series of plants is described in detail, with specifications for both engine and generator given to make it comparatively simple for the reader to select the proper type of generating plant for his particular needs.

A chart of representative models within each specific series outlines such details as capacity of the plant, model number, voltage, starting method, dimensions and weight.

In addition to the standard line of Onan products, the company's new high-capacity gasoline and diesel engine-driven generating plants are listed for the first time in catalog form. Ranging up to 170,000 watts (gasoline) and 230,00 watts (diesel) these new Onan plants are designed for standby service.

Optional accessories for each series of generating plants are also illustrated.

This new 1960 Onan Electric Plant Catalog is available without charge by writing the manufacturer. *D. W. Onan & Sons, Inc.*

Circle number (16) on reply card.

For The "MR. CAP" They Chose a

Thompson VIBRATING SHALE SHAKER

Thompson . . . Perfect for Offshore Work!

On offshore rigs the reclamation of mud is vitally important and the separation of shale and abrasives from drilling muds means a more effective, time and money saving drilling job. Barnwell Offshore, Inc. chose Thompson for their new offshore rig, the MR. CAP, because it was field proven, will give them clean mud and make tools last longer, with a minimum of re-tooling and restoration of mud solution.

A Thompson Separator is your surest bet onshore . . . offshore . . . for shallow, medium and deep wells. The dependable Sample Machine works simultaneously with the separator, giving a foot-by-foot mud analysis with specimens. Write for Folder.

THOMPSON TOOL CO.
IOWA PARK, TEXAS

SOLD ONLY THROUGH SUPPLY STORES

Turbine Pump Motors

A new full-color brochure, Bulletin No. F-1975, on recently released Unibase Turbine Pump Motors, Type HV-1, with the U. S. Microset Coupling, is now available.

The new brochure features a cross-section of the motor, characterized as the "first vertical pump motor designed for short-coupled industrial pumping service," and a full explanation of the motor's various design features. It details the integral construction that eliminates the usual spacer base, gives easy access to the coupling, and provides the strength for the bracket rigidity needed for direct coupling.

It also shows in detail and explains the coupling which permits speedy fine-adjustment of the pump impellers without requiring shaft disassembly. *U. S. Electrical Motors, Inc.*

Circle number (17) on reply card.

Turbine Pump Bulletin

New 8-page bulletin No. S-111 illustrates and describes the latest features incorporated in the new design of turbine pumps. Also included in the bulletin are: Exploded views, selection tables, limitation charts, dimensions, construction specifications, and detailed engineering-architects specifications.

This line of pumps has capacity range up to 150 gpm, pressures to 300 psi, and temperatures to 275 deg F. They are especially adapted to applications such as: Boiler feed, condensate return, fresh water service, brine service, ice water circulation, filter service, LPG service, transfer service, caustic liquid handling, sprinkler service, spraying service, water treatment, and booster service. *Aurora Pump Division, New York Air Brake Company.*

Circle number (18) on reply card.

Ductile Iron Regulator

New 4-page bulletin on the first ductile iron regulators and control valves is now available.

Bulletin J-DI is also a condensed catalog and fully illustrates all sliding gate and plate regulators and control valves now available in ductile iron.

Bulletin describes in detail the composition, properties, specifications, comparison tables on steel, cast iron, and red brass, and the results of a severe quence test on ductile iron valves, and explains how ductile iron is able to replace steel in many applications at a considerable cost savings. It also illustrates and describes the patented sliding gate seats. *OPW-Jordan.*

Circle number (19) on reply card.

THE OLD "WORK HORSES" OF PRIMARY CEMENTING

The preponderant use of Larkin Floating and Guiding Equipment is a natural result of its years of dependable performance.

Experience brings confidence — and that's why thousands upon thousands of wells each year are cemented through Larkin Equipment.

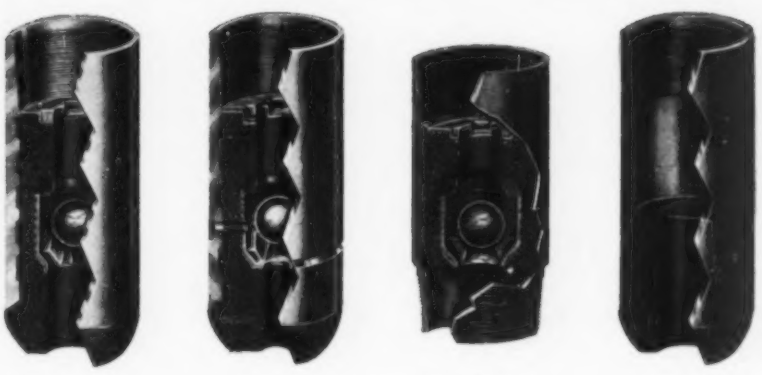


FIG. 302 FIG. 322 FIG. 401 M&F FIG. 202

LARKIN

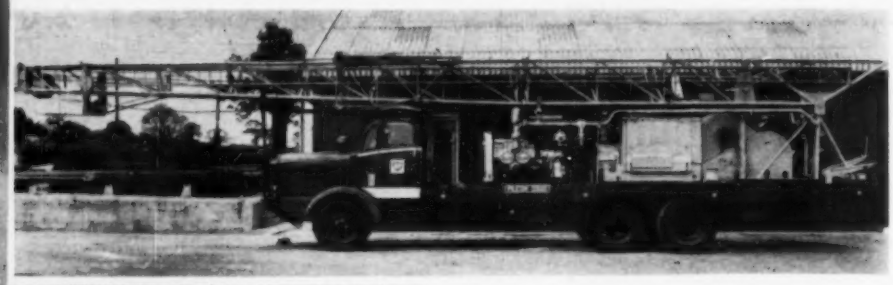
...Through Your Supply Store

LARKIN PACKER COMPANY, INC.

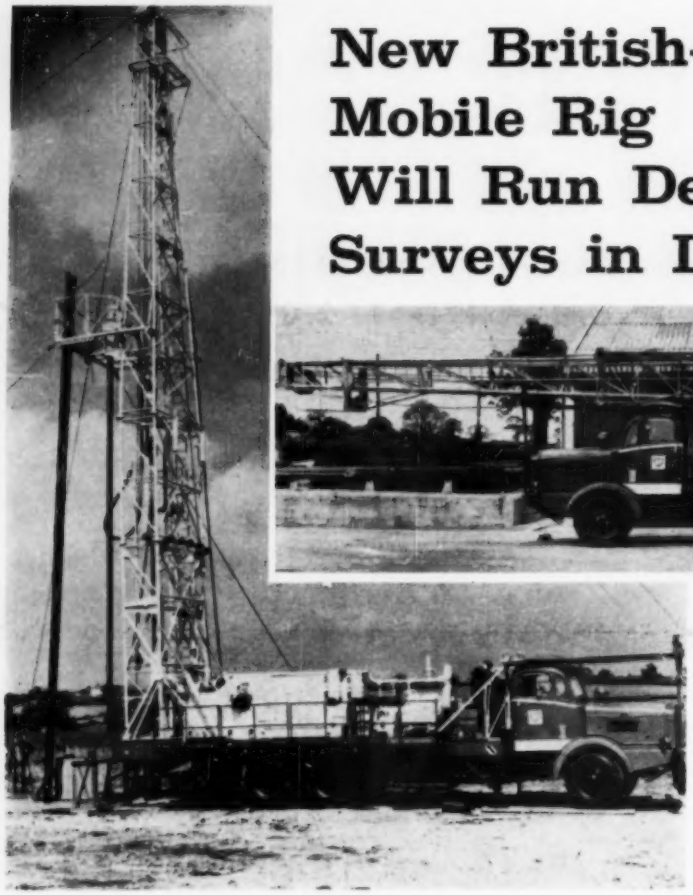
WAXAHACHIE, TEXAS

LARKIN LEADERSHIP HAS BEEN EARNED BY YEARS OF DEPENDABLE PERFORMANCE

New British-Built Mobile Rig Will Run Deep Surveys in Libya



◆ FIG. 1. Folded position of compact new mobile drilling rig shows unit as it will appear when ready to move out on locations in the Libyan desert. Four heavy screw-down jacks mounted on the chassis fold clear for traveling.



◆ FIG. 2. Tubular steel mast is raised by hydraulic rams, gives 58 ft clearance above the rotary table, and has 60,000 lb capacity. It has a fitted removable crown, racking and stabbing platform, and crow's nest.

A NEW MOBILE drilling rig has been shipped from England to Libya, where British Petroleum Exploration Company (Libya) Ltd., will use it for deep stratigraphic survey work on their leases. The rig, designed and built by British companies, has the capacity for drilling with 2⅞-in. drill pipe to a depth of 2500 ft or to 4000 ft with 2⅜-in. pipe.

The rig is mounted on a British-built truck with a 21-ft wheelbase. Four heavy screwdown jacks mounted on the chassis fold clear for traveling. A tubular steel mast is raised and lowered by hydraulic rams, and gives 58-ft clearance above the rotary table with 60,000-lb capacity.

The double drum drawworks is designed for a hook load of 35,000 lb off the main drum, and the rotary table has 18-in. diam opening.

Other specifications on the British Petroleum rig:

1. Engines: Two engines each develop 96 bhp at 1600 rpm and are fitted with fluid couplings and air starters.
2. Main gearbox: Chain drives and helical gearing in compact pressure-lubricated arrangement compounds both engines.
3. Mud pump: Discharge at 400 psi rated pressure is 242.4 gal per min in high speed, 194.4 gal per min in low speed.
4. Drawworks: Enclosed double drum equipped with air clutches and fitted air breakout cathead and plain cathead. Main drum has eight speeds forward, with hook speeds from 34 to 250 ft per min, and two speeds reverse. There are two brake drums off each, with 32-in. diam by 6¾-in. width. The sand reel has four speeds forward ranging from 109 to 524 ft per min, and one reverse speed. Its maximum load is 4246 lb, and its brake drums have a 28-in. diam by 5¼-in. width. Line capacity is 3500 ft of 7/16-in. diam wire line.
5. Rotary table: Construction includes spiral bevel gears, integral pressure lubrication, split master bushing to receive API kelly bushing. The full opening is 18-in. diam. Speeds are 39 to 190 rpm forward, 24 rpm reverse.
6. Mast: Tubular steel, four-way electrically welded mast has clear working height of 58 ft over the table and 60,000-lb capacity. It has hydraulic elevation, fitted removable crown, racking and stabbing platform, crow's nest, ladder, and catline sheave.
7. Traveling block: The sheave has a spring-loaded duplex hook and a capacity of 55,000 lb.
8. Rotary swivel: Features of the rotary swivel are a fitted taper-roller thrust bearing, slip-in washpipe and packing for easy replacement, 2¼-in. diam water course, and 50,000-lb capacity.
9. Kelly: The alloy steel forged fully heat-treated kelly is 4¼-in. hexagonal by 28-in. long, and it has a 2¼-in. bore.
10. Controls: All units are remote controlled from convenient panel at driller position, pneumatically operated controls are powered by twin compressors.
11. Lighting: A comprehensive system is supplied from a generator wired for emergency lighting to the vehicle's batteries. ★ ★ ★

REFINING Engineer

Refining and Petrochemical Metals

For your next project... avail yourself of

PRACTICAL EXPERIENCE

Your industry is [illegible] engineering processes is [illegible] staff of Stearns-Roger has [illegible] the many areas in which [illegible] engaged: metallurgy, power, atomic energy, [illegible] processing, and oil and gas processing. [illegible] ever alert to new designs for more efficient [illegible] arrangement or operation.

Stearns-Roger has for years been closely identified with the oil and gas industry. Processing plants designed and built by Stearns-Roger operate from the extreme cold of Canada to the mild conditions of the Texas Gulf, ranging from the very large to the very small.

Starting with analysis of well-head gas, S-R facilities are complete for handling each successive step through process design, general engineering, fabrication of special equipment in our shops, and field installation with our own personnel. We deliver a completed plant, operating, to meet the customer's long term needs.

Stearns-Roger

THE STEARNS-ROGER MFG. CO. • DENVER, COLORADO

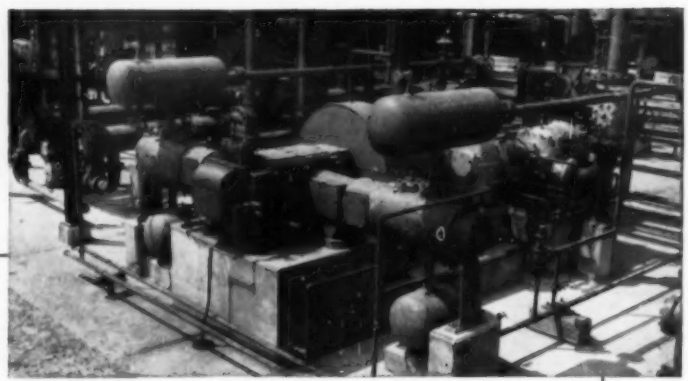
DENVER • HOUSTON • EL PASO • SALT LAKE CITY

Stearns-Roger Engineering Company, [illegible]
Calgary, Alberta

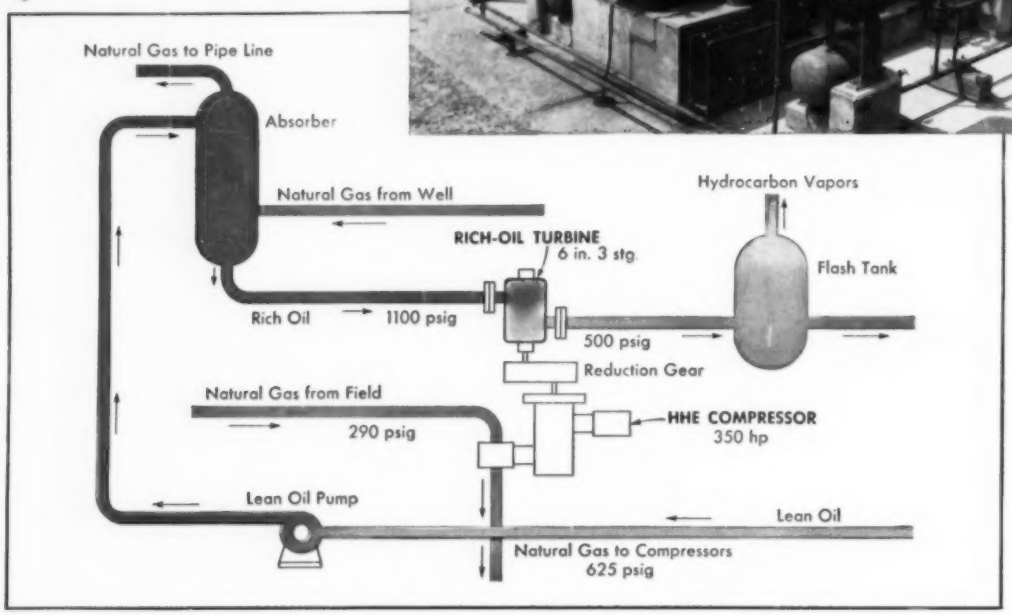
PUTTING "WASTE HORSEPOWER" TO WORK

By driving Ingersoll-Rand Compressors with I-R Rich-Oil Turbines, La Gloria Oil & Gas Company recovers 1000 hp

One of three Ingersoll-Rand HHE compressors driven by a 350-hp I-R 6-inch, 3-stage rich-oil turbine (shown at right) at the La Gloria natural gasoline plant.



Schematic flow diagram of the absorption cycle, simplified to show only one flashing stage. In this plant, three 350-hp turbines are installed between absorbers and high-pressure flash tanks, and two I-R 4-inch, 2-stage 150-hp turbines are located between high-pressure and low-pressure flash tanks.



In the absorption process for natural gasoline extraction, rich oil from the absorber must be reduced in pressure before going to the still. This pressure reduction is usually accomplished by a reducing valve that does no useful work. But by putting an I-R *rich-oil turbine* in place of the reducing valve, other equipment can be driven by the horsepower recovered in the pressure reduction process.

This "free" energy recovery is well illustrated at La Gloria Oil & Gas Company's plant near Corpus Christi, Texas. Here, three Ingersoll-Rand gas compressors are driven by I-R three-stage rich-oil turbines each of which is designed to recover 350 hp from its rich oil stream. As shown in the schematic diagram above, the compressors boost 290-psi gas from the absorber to 625 psi for further compression. The rich-oil turbine reduces pressure from 1100 psi to 500 psi, operating at 3350 rpm and driving the compressor through reduction gears.

Does *your* process plant have idle fluid horsepower that could be put to work? Your I-R representative will be glad to give you complete information on rich-oil turbines, compressors and pumps for any application.

Ingersoll-Rand

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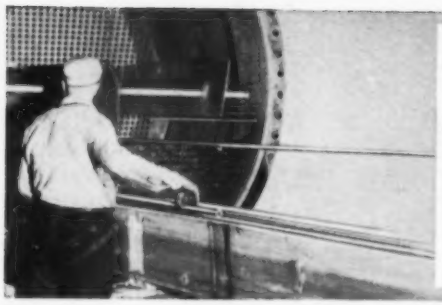

CONDENSER AND HEAT EXCHANGER CLINIC

Edited by A. W. Tracy, Metallurgical Engineer
The American Brass Company, Waterbury, Conn.

OPERATING FACTORS THAT AFFECT CONDENSER TUBE LIFE

Answers to some of the questions sent in following a previous clinic on this subject

Q. How effective is chlorination as a preventive maintenance procedure in cleaning tubes fouled by polluted water?

A. The chlorination of polluted sea water has been found to be effective in removing or preventing the formation of slimes on the walls of tubes. Better cleanliness was indicated by higher vacuum obtained on the steam side of the condenser. Tubes kept clean by chlorination have been reported to be less subject to pitting. It should be interjected here that tubes carrying polluted sea water containing sulfides from decomposition of organic matter seldom undergo inlet end corrosion, but the remainder of the length of the tubes often becomes pitted. Clean sea water, if entering the tube turbulently, will often cause corrosion at the inlet end, and usually the remainder of the length of the tube is coated with a good protective film of corrosion products.

The statement that chlorination may break down sulfide films on the walls of tubes is based on the fact that chlorine is an oxidizing agent and would oxidize sulfides; however, it is realized that the usual chlorine treatment would probably not remove thick long-standing sulfide scales.

Q. How often should tubes be cleaned and what are some of the methods used?

A. The required frequency of tube cleaning depends, of course, on how rapidly the tubes become fouled. In some power plants, tubes are cleaned once a week; at other stations, cleaning is required only at intervals of several months. Often the decision to clean tubes is determined by the drop in vacuum on the steam side.

In regard to methods for removing accumulations from condenser tubes, some station operators shoot rubber plugs through the tubes; others use bristle brushes, either of animal hair or nylon. The use of brushes is reported by some to do a better job of cleaning than the use of plugs.

An interesting method for continuously cleaning condenser tubes has been developed in Europe. A large number of sponge rubber balls, slightly larger in diameter than the inner diameter of the tubes and having about the same specific gravity as sea water, is fed continuously into the inlet water box. The cooling water forces the balls through the tubes, and deposits on the tube walls are swept away. The balls are collected by a cone in the outlet water box. They leave the water box through a tube connected to the end of the cone and are recirculated into the inlet water box. By the law of probability, each tube will eventually receive a ball. The system is not applicable to tubes that have been in service and have become rough and pitted.

Some stations periodically remove deposits from tubes by recirculating a dilute, inhibited hydrochloric acid solution through the condenser.

Q. How important are temperature and velocity as factors in the service life of condenser tubes?

A. Corrosion of condenser tubes is usually more rapid in summer than in the winter, but pollution due to bacterial action in the summer may be a more important factor than temperature itself. Instances have been observed where failures in a set of tubes occurred only in the warm-water months and none in the cold-water months, over a period of several years.

Mention was made in the clinic to the effect that high temperature of water causes pitting, due to the formation of gas bubbles on the tube wall. This type of pitting occurs most frequently, but not often, in oil refinery condensers where temperatures on the vapor side may be as high as 350F and water velocities relatively low. In a power plant condenser, temperatures on the vapor side ordinarily do not exceed 100F and temperature rise in the cooling water from the inlet to the outlet end is usually limited to 10F.

TECHNICAL ASSISTANCE. Our Metallurgical Department is regularly helping manufacturers, electric power companies, marine operators, petroleum and chemical companies to select the correct tube alloy for many types of condensers and heat exchangers. This service is available to you without obligation. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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Customer fuels are prepared for road rating in Ethyl's controlled-weather chassis dynamometer room.

Ethyl Research evaluates current premium fuels

Makes Results Available to Industry

One hundred thirty-one motor gasolines—112 premium and 19 super premium fuels—have been thoroughly tested in the laboratory and on the road in Ethyl's latest study of premium fuel performance.

Results of the study—including road performance evaluations for both full throttle and part throttle operation—are available to refiners as an aid to understanding current fuel problems and planning future fuels. In addition, Ethyl Research has expanded and brought up to date its system for calculating road performance from routine laboratory data.

All tests were conducted at Ethyl's Detroit Research Laboratories. Road tests were made in five 1959 cars and three test cars equipped with experimental high compression engines.

Of special interest is the information on part throttle operation since some late model cars are knock-limited at part throttle.

Summary of Ethyl Research Findings

1. Laboratory octane numbers may be used to provide estimates of road antiknock performance in 1959 cars. Whether Research or Motor octane number is more important varies with the car, engine speed and throttle setting.

2. A fuel property such as hydrocarbon composition and either Research or Motor octane also is a good index of road performance.

3. Low speed road performance in 1959 cars at full throttle operation depends primarily on Research octane number. For high speed, Motor octane is more important.

4. Experimental high compression cars were more ap-

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preciative of Research octane number than the 1959 cars.

5. Part throttle road behavior is controlled almost entirely by Motor octane. An increase of sensitivity is generally detrimental.

6. Where Research octane is the same, fuels with maximum paraffin hydrocarbons give optimum road performance.

7. Where Research octane and sensitivity are the same, fuels with more aromatics and less olefins show better road performance at high speeds.

Scope of the Test Program

Fuels tested in this study were obtained from 114 refineries representing 77 percent of the motor gasoline produced in the United States and Canada.

More than 3,500 separate laboratory tests were made, including 1,820 CFR engine tests. And more than 16,000 road ratings were made—14,200 at full throttle and 2,000 at part throttle—with the fuel samples blended to a TEL concentration of 3.0 ml per gallon.

The empirical correlation between road antiknock behavior and the laboratory characteristics of current premium gasolines was exhaustively re-examined to provide an accurate, up-to-date means for study of current fuel performance in today's cars.

Work with experimental high compression engines produced data which will be of great help in predicting future fuel performance and requirements.

AVERAGE COEFFICIENTS IN EQUATION RELATING ROAD OCTANE NUMBER TO LABORATORY VARIABLES

$$\text{Road ON} = a + b\,(\text{Research ON}) + c\,(\text{Motor ON}) + d\,(\%\ \text{Olefins})$$

FULL THROTTLE

FIVE 1959 CAR AVERAGE	A	B	C	D
Modified Uniontown	28.90	0.419	0.325	−0.038
Modified Borderline				
2000 rpm	11.48	0.644	0.273	−0.027
2500 rpm	26.84	0.408	0.359	−0.054
3000 rpm	27.50	0.371	0.386	−0.083
3500 rpm	21.99	0.313	0.502	−0.107

How Ethyl Research can help you

Since 1946, Ethyl Research Laboratories in Detroit have studied laboratory and road performance of premium grade gasolines at periodic intervals. This recent program is the largest undertaken.

For oil company statistical groups that wish to make further computer analysis of the data, Ethyl Research will supply a deck of IBM cards containing all available fuel variables and all road ratings for fuels at full throttle. Cards also are available for part throttle ratings for 28 car-speed combinations on 30 fuels.

Copies of the report compiled on this program entitled, "1959 Premium Gasoline Antiknock Behavior," may be obtained from your Ethyl Representative. He will gladly arrange for a presentation by an Ethyl Refinery Technologist.

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A Challenge for the

Frank H. Walk
Frank H. Walk & Associates, New Orleans, Louisiana

THOSE OF US who deal everyday with the engineering design of new facilities for the refining and petrochemical industries do not always stop to realize the all important part played by metals in these plants. We are, really, for the most part, "too close to the forest to see the trees," i.e., too involved in actual design and selection of equipment to fully appreciate how vital metals are to the very existence of these industries.

If we were asked to select the one supporting element which through its own improvement and progress has contributed the most to general progress in the refining industry, it would certainly be difficult to find a better one than the metals industry. For the most part, we are inclined to mark progress in refining by the development of new processes, yet these new processes have been possible only because of new equipment, which in turn was entirely dependent on some new metals for its successful functioning. The development and proper application of new metals has contributed materially to the reduction of refinery down time, an all important element in operating economics. Thanks to new metals, turnarounds are now not only further apart, but also much less costly. General maintenance costs on equipment both within and outside battery limits have been greatly reduced by the proper usage of new or improved metals.

"It may not always be the best design practice to adopt the course that is best technically . . . but those responsible for design practice can never form a right judgment without knowledge of what is right technically"
— Anon.

Yet, in spite of the many advances in refining over the past quarter century (which can be attributed, either directly or indirectly, to technological improvements in metals) many more such opportunities even now stand ready for the taking.

Too often we are prone to base our designs and material selections entirely on previous practice. It is easier to do things the same old way, and, in addition, there is less risk of error.

Certainly there are no greater deterrents to progress in engineering design and improved plant facilities than complacency and the failure to exercise initiative.

Each new engineering design and each new facility resulting therefrom should be an improvement over all similar existing facilities. Previous designs and practices guide the way to new designs, but should never govern since consideration should always be given to recent advances in general technology, even though these may not have been proved beyond the laboratory stage, or may have been tested only in an analogous application in some other field of industry.

The term "metals" has become a name used rather loosely to apply to a large and ever increasing variety of materials ranging from inexpensive mild carbon steel to costly alloys, and from hot rolled structural shapes to intricate forgings or centrifugal castings. Of course, we all know about the basic division between ferrous and nonferrous metals and recognize such products as cast iron, steel and wrought iron as belonging to the first group, and aluminum, copper and zinc as part of the second category. We also know generally what properties can be expected from these and some of the more commonly used alloys, and about heat treating and stress relieving techniques. But, how many of us would be lost if plain old ASTM A-7 structural steel, ASTM A-53 pipe and Type 316 stainless sheets were suddenly

DESIGN ENGINEER

unobtainable? Have we ever fully evaluated the advantages of using low alloy ASTM A-242 structural from both strength and corrosion resistance viewpoints? Do we know that high test API 5LX pipe can be advantageously used in refinery work outside of the battery limits? Have we looked into the possibilities of using clad or the new coated steel sheets, in lieu of solid alloys, with a great cost savings? Are we sufficiently familiar with how centrifugally cast ferritic alloy steel pipe can be employed in high temperature service? These and many other similar products can be our key to better basic designs in the future.

Our search for different metal products that can be advantageously employed in plant design should not be limited to those items which go into the operating units. For example vinyl, polyester or ceramic coated steel panels can be used in the design of control buildings, changehouses and stores warehouses; and new products like steel roof structural systems (patented) might well be used for the roof on these type structures.

"The art of progress is to preserve order amid change, and to preserve change amid order. Technology refuses to be embalmed alive, the more prolonged the halt in some unrelieved system of order, the greater the crash of the dead technology"
— Anon.

As engineers we must not only keep looking for better ways to design our refineries and petrochemical plants in normal times, but we must also keep alert to the possibilities of substitution in times of material shortage. When national defense efforts, strikes, etc. threaten the ready source of supply for materials which we normally use, we should know in advance of alternates which are available from domestic sources, and we must not overlook the ever increasing availability of a wide range of metal products from foreign manufacturers. European steels, long inferior to our U. S. products, have improved considerably in the last decade through the employment of new manufacturing equipment, particularly finishing facilities. Japanese steels, which are made in large new open hearth furnaces and new finishing mills, are now even superior to the European products which still utilize the old "Thomas method" Bessemer convertors to a large extent. In general, however, both European and Japanese steels are now readily available in a wide variety of types, sizes and shapes which are manufactured to our own U. S. standards, including close control and uniform quality considerations.

Another factor which we, as engineers, must consider in our designs and material specifications is the geographical location in which facilities are to be constructed. Aside from the climatic conditions, which is an all important design element, the availability of materials manufactured in local or nearby areas must be considered. Designs employing the use of such metals can effect important construction cost savings, especially if the plant is located on foreign soil.

We have given thought to the opportunities which are open to engineers for better equipment and plant design through the use of materials already available on the market. However, an even greater mass of opportunities will be unfolding in the near future. Our U. S. metals industries are, at this moment, on the threshold of what they have termed a technological "explosion," a rapidly increased pace for the development of new products designed to meet the requirements of all industry; metals that will better cope with the high and low temperatures, pressures, corrosion and abrasion encountered in our industries. *Are we ready to meet the challenge of this opportunity?*

An ASTM Subcommittee Chairman Discusses . . .

ASTM A426-58T Alloy Steel Centrifugally Cast Pipe

for high temperatures giving the high points of the specification as well as supplementary information of primary interest to refinery engineers who design and specify piping systems

Helmut Thielsch, *Metallurgical Engineer*
Grinnell Company, Inc., Providence, Rhode Island

ALLOY STEEL cylindrical shapes have been produced in the United States and in Europe for some 20 years by the centrifugal casting process. The initial applications for centrifugal castings were primarily cylindrical shapes such as rolls for paper mills, gun barrels, etc. However, during the past decade, spurred on by the frequent immediate unavailability of wrought pipe products in the larger diameters and heavier wall thicknesses, increasing interest has been turned by pipe consumers to centrifugal cast pipe.

Improvements in the quality of the centrifugally cast pipe and the availability of lengths of 20 ft and longer from several centrifugal casting producers, has resulted in considerable tonnage of alloy steel pipe being purchased by the refinery industry for service conditions involving temperatures as high as 1050 F and pressures up to 800 psi. In fact, many refinery engineers feel a potential use of centrifugally cast piping in the majority of high-temperature high-pressure refinery applications. The primary deterrent to date to the greater use of centrifugally cast piping has been the lack of recognized ASTM specifications. Refinery engineers have been particularly interested in obtaining Code recognition of these materials.

Where the pipe had been produced under exacting standards, including machining of outer and inner surfaces and thorough surface inspection, the piping has given satisfactory high temperature service for periods of as much as 10 years. There is no evidence to suspect that this satisfactory service performance is not likely to continue.

NEW ASTM SPECIFICATION

Because of the increasing use by the refinery industry and the significant interest by other consumers in alloy steel centrifugally cast piping, a Task Force was set up by Subcommittee XXII of Committee A-1 of the American Society for Testing Materials on which various producers and consumers of piping were represented. Purpose of the Task Force was to prepare a specification for alloy steel pipe made by the centrifugal casting process for high-temperature service.

Specification ASTM A426-58T* written by the Task Force covers carbon-molybdenum and chromium-molybdenum steel grades. Although prepared for a type of cast material, the chemical and mechanical requirements were based on the requirements of the other applicable ASTM high-temperature specifications covering wrought piping grades, such as A335** (wrought seamless pipe) or A369† (forged and bored pipe) rather than the corrseponding ASTM specification applicable to sand cast grades as A217†† (alloy steel castings as valves, flanges, fittings, etc.). For example, the chemical requirements in the proposed specification (see Table 1) are the same as in A335. The identifying numbers tentatively assigned correspond to those used in the piping specifications. The Task Force believed that the extensive use of centrifugal cast steel piping in high-temperature service applications would require that the centrifugal cast grades are furnished essentially to the same chemical and physical requirements as the wrought piping grades now commercially used.

However, in comparison to the requirements of the several ASTM alloy steel pipe specifications applicable to high temperature service as A335 and A369 the following additional requirements have been included in Centrifugally Cast Piping specification.

Process

The steel shall be made by the electric furnace process.

Machining

a. All centrifugal castings shall have both the inner and outer surfaces machined.

b. The pipe shall be machined to a finish not coarser than 250 rms after heat treatment.

*ASTM A426-58T "Centrifugally Cast Ferritic Alloy Steel Pipe for High-Temperature Service."

**ASTM A335-55T "Seamless Alloy Steel Pipe for High-Temperature Service."

†ASTM A369-55T "Ferritic Alloy Steel Forged and Bored Pipe for High-Temperature Service."

††ASTM A217-58T "Alloy Steel Castings for Pressure Containing Parts Suitable for High-Temperature Service."

TABLE 1. Chemical Requirements.

Grade	Carbon percent	Manganese percent	Phosphorus, max. percent*	Sulfur max. percent*	Silicon percent	Chromium percent	Molybdenum percent
CP1	0.10—0.20	0.30—0.80	0.045	0.045	0.10—0.50	—	0.44—0.65
CP2	0.10—0.20	0.30—0.61	0.045	0.045	0.10—0.50	0.50— 0.81	0.44—0.65
CP3	0.15 max.	0.30—0.60	0.030	0.030	0.40—0.80	1.45— 2.05	0.60—0.81
CP3b	0.15 max.	0.30—0.60	0.030	0.030	0.50 max.	1.65— 2.35	0.44—0.65
CP5	0.15 max.	0.30—0.60	0.030	0.030	0.50 max.	4.00— 6.00	0.45—0.65
CP5b	0.15 max.	0.30—0.60	0.030	0.030	1.00—2.00	4.00— 6.00	0.45—0.65
CP7	0.15 max.	0.30—0.60	0.030	0.030	0.50—1.00	6.00— 8.00	0.44—0.65
CP9	0.15 max.	0.30—0.60	0.030	0.030	0.25—1.00	8.00—10.00	0.90—1.10
CP11	0.15 max.	0.30—0.60	0.030	0.030	0.50—1.00	1.00— 1.50	0.44—0.65
CP12	0.15 max.	0.30—0.61	0.045	0.045	0.50 max.	0.80— 1.25	0.44—0.65
CP15	0.15 max.	0.30—0.60	0.030	0.030	1.15—1.65	—	0.44—0.65
CP21	0.15 max.	0.30—0.60	0.030	0.030	0.50 max.	2.65— 3.35	0.80—1.06
CP22	0.15 max.	0.30—0.60	0.030	0.030	0.50 max.	1.90— 2.60	0.87—1.13

*The maximum phosphorus and sulfur permitted are to be in accordance with ASTM Specification A335 for which possible changes are now being contemplated.

Tensile and Hardness Properties

Tensile and Brinell hardness requirements shall be as follows:

Tensile strength,
- Grades C-Mo and ½ Cr – ½ Mo... 55,000 psi, min.
- All other grades..... 60,000 psi, min.

Yield point,
- All grades ..... 30,000 psi, min.

Elongation 2 in. gage length (Standard round specimen)
- All grades (transverse and longitudinal) ..... 22%, min.

Brinell hardness,
- Grades 5 Cr, 7 Cr and 9 Cr..... 225 max.
- All other grades..... 201 max.

Helmut Thielsch *has been the Metallurgical Engineer for the Grinnell Co., Inc., since January 1954. In this capacity he is in charge of the Industrial Piping Laboratory concerned with research and development of procedures for the fabrication, bending and welding of piping, the investigation of service failures, etc. He is also responsible for the company's fabrication and welding procedure specifications, shop inspection procedures and the adoption of new fabricating and field welding techniques. As a member of various ASTM, AWS, ASME and other technical and code-writing committees, he has kept in close contact with the latest techniques in welding and in weldment and pipe fabrication.*

Previous to 1952 he was associated with the Welding Research Council where he prepared extensive literature reviews and interpretive reports covering a wide range of subjects pertaining to the welding field.

His earlier experiences include metallurgical and engineering responsibilities with Allis-Chalmers Mfg. Co., Black, Sivalls & Bryson, and the Lukens Steel Company.

He has authored more than 70 technical and research articles on various welding, fabrication and metallurgical subjects and has contributed to Volume IV of the ASME Handbook series.

He is a member of the AWS, ASM, ASME, ASTM, ACS, NACE and SNT technical societies. He is presently Chairman of the Providence Section of the American Welding Society.

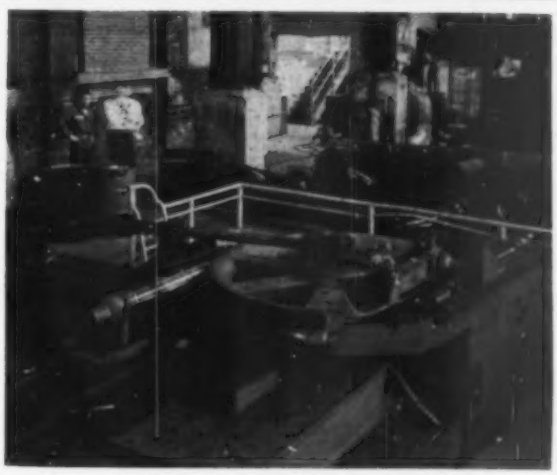

FIG. 1. Cold bending of 8 in. Sch. 160 centrifugally cast 2¼ Cr — 1 Mo pipe section.

Ultrasonic Tests

a. Each pipe shall be ultrasonically tested to determine its soundness throughout the entire length of pipe. Evidence of the existence of defects in excess of 5 percent of the wall thickness shall be cause for rejection or repair.

b. The ultrasonic test shall be made in accordance with the Recommended Practice for Ultrasonic Testing by the Reflection Method, Using Pulsed Longitudinal Waves Induced by Direct Contact (ASTM Designation: E114) or by any other established method mutually agreed upon between the manufacturer and the purchaser.

Magnetic Particle or Penetrant Fluid Examination

a. Each pipe along outside and inside surfaces shall be subjected to examination by a magnetic particle method or a penetrant fluid or powder method after machining and hydrostatic testing.

b. Magnetic particle inspection shall be made in accordance with the Method for Dry Powder Magnetic Particle Inspection (ASTM Designation: E109).

c. Details of the penetrant fluid and powder method shall be a matter for agreement between the manufacturer and the purchaser.

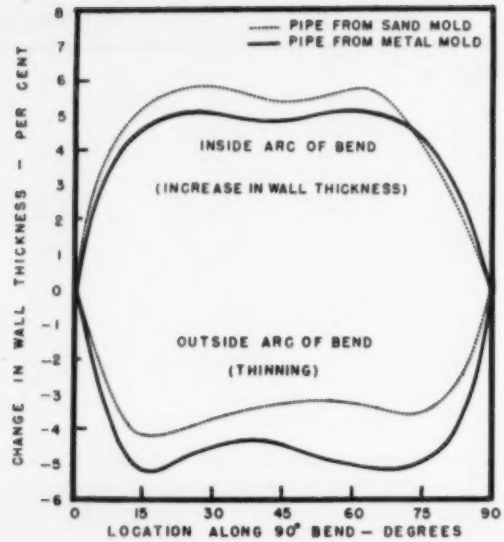
PIPE FROM SAND MOLD
PIPE FROM METAL MOLD
INSIDE ARC OF BEND
(INCREASE IN WALL THICKNESS)
OUTSIDE ARC OF BEND
(THINNING)
CHANGE IN WALL THICKNESS - PER CENT
LOCATION ALONG 90° BEND - DEGREES

FIG. 2. Change in wall thickness of 8 in. OD Sch. 160 centrifugally cast 2¼ Cr — 1 Mo pipe cold bent to a 5 diam radius.

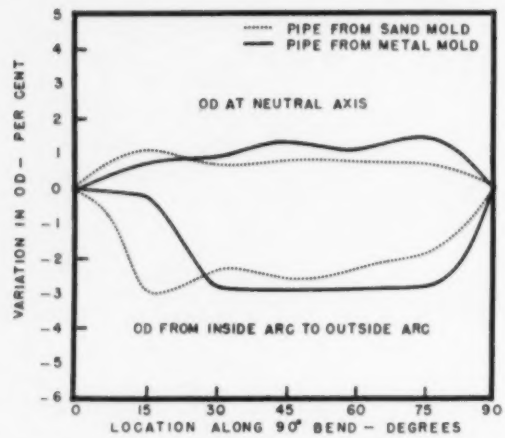
PIPE FROM SAND MOLD
PIPE FROM METAL MOLD
OD AT NEUTRAL AXIS
OD FROM INSIDE ARC TO OUTSIDE ARC
VARIATION IN OD - PER CENT
LOCATION ALONG 90° BEND - DEGREES

FIG. 3. Flattening in 8 in. OD Sch. 160 centrifugally cast 2¼ Cr — 1 Mo pipe cold bent to a 5 diam radius.

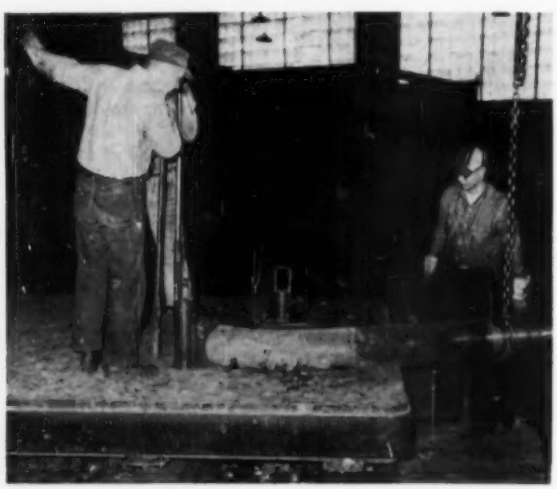

FIG. 4. Hot bending of 8 in. Sch. 160 centrifugally cast 2¼ Cr — 1 Mo pipe section.

Permissible Variation in Dimensions

Diameter — Inside diameter shall not vary under that specified by more than 1/16 in. There shall be no variation over the specified inside diameter.

Thickness — Wall thickness shall not vary over that specified by more than 1/16 in. There shall be no variation under the specified wall thickness.

The inclusion of the Brinell hardness limitations and the ultrasonic inspection and magnetic particle or dye-penetrant fluid examination requirements in the body of the specification makes this the tightest piping specification prepared to date, since these inspection methods are not requirements of the other ASTM piping specifications.

Moreover, the surface finish requirements and tolerances in diameter and thickness may reduce somewhat welding and material costs. For example, wrought pipe furnished under Specification A335 in diameters between 8 and 18 in. OD may have a variation in OD of +3/32 in. and −1/32 in. In addition, the minimum wall thickness may be 12½ percent less than the nominal wall thickness. These relatively broad tolerances frequently require weld build-up and internal machining of the pipe ends to be welded. Moreover, heavier wall thickness may have to be purchased in order to allow for the 12½ percent minimum wall thickness.

The several producers represented on the Task Force felt that they could readily meet these additional inspection requirements. Reason for the tighter inspection requirements was that although many producers do produce quality pipe, the danger of defective piping or workmanship was also greater with inexperienced producers; the additional

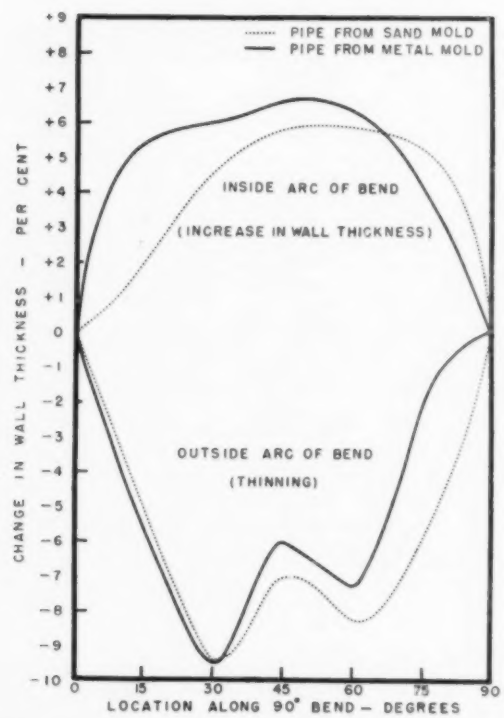
PIPE FROM SAND MOLD
PIPE FROM METAL MOLD
INSIDE ARC OF BEND
(INCREASE IN WALL THICKNESS)
OUTSIDE ARC OF BEND
(THINNING)
CHANGE IN WALL THICKNESS - PER CENT
LOCATION ALONG 90° BEND - DEGREES

FIG. 5. Change in wall thickness of 8 in. OD Sch. 160 centrifugally cast 2¼ Cr — 1 Mo pipe hot bent to a 3 diam radius.

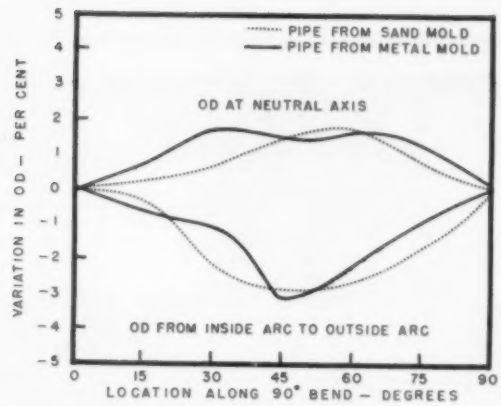

FIG. 6. Flattening in 8 in. OD Sch. 160 centrifugally cast 2¼ Cr — 1 Mo pipe hot bent to a 3 diam radius.

requirements, therefore, providing some insurance for a quality product.

Almost all applications of centrifugal cast piping in high temperature service have been in oil refinery service. No use has been made to date of chromium-molybdenum steel grades in steam plant service. Moreover, at present high temperature creep and stress-rupture test data are very limited. Because of this lack of technical data, the ASTM committee included in the *Scope* clause of the specification that this material is intended for oil refinery and other similar high-temperature service. Upon the availability of sufficient test data, the *Scope* clause may be further broadened to include other service applications.

ASA CASE NO. 32

In the meantime, the American Standards Association has written and approved Case No. 32 to permit use of centrifugally cast steel pipe under Section 3 of the ASA B31.1-1955 Code for Pressure Piping.

For chromium molybdenum steel grades the pipe shall meet the requirements of ASTM Specification A217, except that hydrostatic testing shall be done at a test pressure which will produce in the pipe a stress of 90 percent of the specified minimum yield strength.

This case also requires magnetic particle or dye penetrant inspection of the inside and outside surfaces, including ends. On pipe of wall thickness greater than 1 in. ultrasonic testing is also required by either shear or longitudinal wave methods.

Stress values assigned by this Case No. 32 are based on a 90 percent casting quality factor as compared to the corresponding wrought materials as summarized in Table 2.

The ASA Case is intended to represent an interim condition until such time as the ASTM Specification is approved by the ASTM and becomes available and is also accepted by the ASA Committee responsible for writing Case No. 32.

COMMERCIAL CENTRIFUGAL CASTINGS

Centrifugally cast pipe is produced by introducing the molten steel into a spinning mold allowing the metal to solidify under the pressure of the centrifugal force. The mold is usually rotated in the horizontal plane and is turned at speeds to provide a centrifugal force of 50 to 100 times that of gravity. The greater the force (i.e., the rate of spinning) the more dense will be the finished steel, with the limiting density being that of wrought steel.

Two types of molds are used — either molds containing rammed sand with binders or permanent metal molds. Piping made from both types of molds are giving satisfactory service in high temperature service applications. Some authorities claim that sand molds are preferable where the molten steel must flow a considerable distance over the mold surface and where chilling of the cast metal is undesirable. Others feel that with permanent metal molds there is no danger of sand inclusions of the steel and shrinkage voids are eliminated because of the higher cooling rate of metal molds.

Alloy steel centrifugal castings have been produced to date in diameters from about 4-in. OD to 50-in. and in lengths of up to about 20 ft. Their economical advantages increase with pipe of the larger diameters and heavier wall thicknesses.

FABRICATION EXPERIENCE

Normal shop fabricating operations as cold or hot bending, forging, swaging, extruding and vanstoning can be as readily performed on centrifugally cast pipe as on the wrought seamless or forged pipe products. Fig. 1 illustrates cold bending of a 2¼ Cr – 1 Mo 8 in. Schedule 160 piping

TABLE 2. Maximum Allowable Stress Values for Centrifugally Cast Steel Pipe Established in ASA Case No. 32 and Given in the ASME Boiler and Pressure Vessel Code for Comparable Wrought and Cast Grades.

Base Metal Type	Process	Corresponding ASTM Grade	Tensile Strength min. psi	Yield Strength min. psi	Max. Allowable Stress Values (psi) at Temperatures — °F									
					-20 to 100	600	800	850	900	950	1000	1050	1100	
0 Cr–½Mo	Centrifugal Cast	ASA—Case No. 32	65000	35000	19500	15450	14100	12950	11250	9000	5650			
	Wrought Seamless	ASTM A335, Gr. P1	55000	30000	13750	13750	13450	13150	12500	8500	5500			
	Forged and Bored	ASTM A369, Gr. FP1	55000	30000	13750	13750	13450	13150	12500	8500	5500			
	Forged	ASTM A182, Gr. F1	70000	40000	17500	17500	16900	15000	12750	8500	5500			
	Static Cast	ASTM A217, Gr. WC1	65000	35000	16250	16250	15650	14400	12500	8500	5500			
1¼Cr—½Mo	Centrifugal Cast	ASA—Case No. 32	70000	40000	21000	16650	15300	14200	12600	9800	7000	4950	3600	
	Wrought Seamless	ASTM A335, Gr. P11	60000	30000	15000	15000	15000	14400	13100	11000	7800	5500	4000	
	Forged and Bored	ASTM A369, Gr. FP11	60000	30000	15000	15000	15000	14400	13100	11000	7800	5500	4000	
	Forged	ASTM A182, Gr. F11	70000	40000	17500	17500	15000	14400	13100	11000	7800	5500	4000	
	Static Cast	ASTM A217, Gr. WC6	70000	40000	17500	17500	17000	15800	14000	11000	7800	5500		
2¼Cr—1Mo	Centrifugal Cast	ASA—Case No. 32	70000	40000	21000	16650	15300	14200	12600	9800	7000	5200	3800	2700
	Wrought Seamless	ASTM A335, Gr. P22	60000	10000	15000	15000	15000	14400	13100	11000	7800	5800	4200	3000
	Forged and Bored	ASTM A369, Gr. FP22	60000	30000	15000	15000	15000	14400	13100	11000	7800	5800	4200	3000
	Forged	ASTM A182, Gr. F22	70000	40000	17500	17500	17500	16000	14000	11000	7800	5800	4200	3000
	Static Cast	ASTM A217, Gr. WC9	70000	40000	17500	17500	17000	15800	14000	11000	7800	5800	3300	
5 Cr–½Mo	Centrifugal Cast	ASA—Case No. 32	90000	60000	27000	21400	17100	15300	12250	9000	6600	4700	3000	2000
	Wrought Seamless	ASTM A335, Gr. P	60000	30000	15000	14000	12800	12400	11500	10000	7300	5200	3300	2200
	Forged and Bored	ASTM A369, Gr. FP5	60000	30000	15000	14000	12800	12400	11500	10000	7300	5200	3300	2200
	Forged	ASTM A182, Gr. F5	60000	30000	22500	20100	14500	13000	11500	10000	7300	5200	3300	2200
	Static Cast	ASTM A217, Gr. C5	90000	60000	22500	22500	19000	17000	13600	10000	7300	5300	3300	2200

FIG. 7. Swaging end of 8 in. OD Sch. 160 centrifugally cast 2¼ Cr — 1 Mo pipe to 3 in. nominal OD.

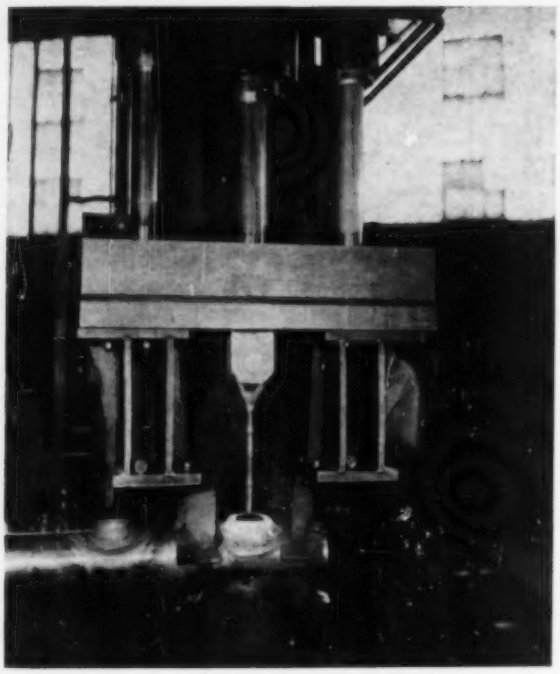

FIG. 8. Extruding nozzle outlet in 8 in. OD Sch. 160 centrifugally cast 2¼ Cr — 1 Mo pipe.

section to a 5 diameter radius. Thinning, Fig. 2, and flattening, Fig. 3, along the outer bend radius are normal for alloy steel piping.

Fig. 4 shows another 8 in. Sch. 160 2¼ Cr – 1 Mo pipe section being hot bent to a 3 diameter radius. No problems were encountered. Thinning and flattening were normal as shown in Fig. 5 and 6, respectively.

Similarly, swaging to a diameter of less than one-half the original OD, Fig. 7, and extruding to the nozzle outlet normally done in shop fabrication practice, Fig. 8, can be performed without difficulty on both sand and metal mold centrifugal castings.

No differences could be noted in the forming characteristics between centrifugally cast pipe from sand or metal molds and wrought, forged and bored or hollow forged pipe normally produced under ASTM Specifications A335 or A369.

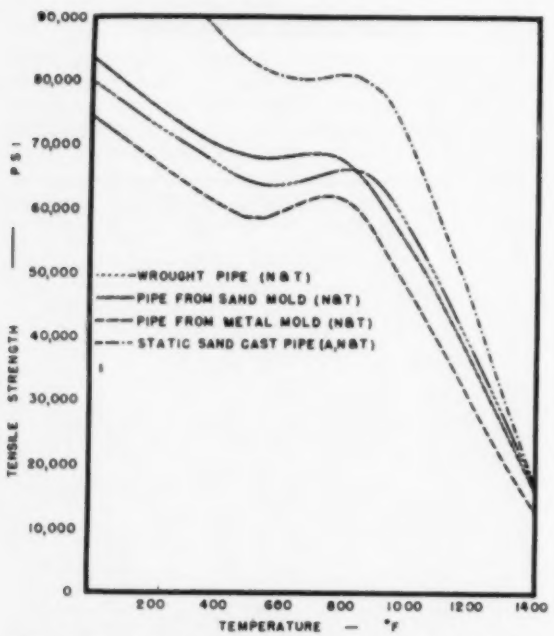

FIG. 9. Elevated-temperature short-time tensile test data in wrought, centrifugally cast and statically sand cast 2¼ Cr — 1 Mo commercial piping materials. (A = annealed, N = normalized and T = tempered.)

HIGH TEMPERATURE PROPERTIES

As mentioned earlier, only a very limited amount of high-temperature test data are presently available on centrifugal piping materials. This is particularly true of long-time creep and stress-rupture tests. Since several industrial and commercial test laboratories are now conducting creep and stress-rupture tests on both sand and metal-mold centrifugal cast chromium-molybdenum steel materials, considerably more data should become available within the next few years.

The results on short-time tensile tests on specimens from commercial sand and metal-mold 2¼ Cr – 1 Mo centrifugal cast pipe are plotted in Fig. 9 and compared to test data obtained on commercial wrought and cast 2¼ Cr – 1 Mo alloy steel pipe of similar wall thickness.

The results of the several creep and stress-rupture tests conducted to date or in progress presently are shown in Fig. 10 and 11 respectively for 2¼ Cr – 1 Mo grades. Allowing for the normal scatter of test data, the comparison with published data[1] indicates no significant differences between

[1]Simmons, W. F. and Cross, H. C., "Report on the Elevated-Temperature Properties of Chromium-Molybdenum Steels" ASTM Special Technical Publication No. 151.

the centrifugal cast and wrought chromium-molybdenum steel grades. In a similar study made by General Electric Company on 1¼ Cr – ½ Mo steel piping, it is concluded that "the rupture strength of the 1¼ Cr – ½ Mo centrifugal cast and annealed piping is comparable to pierced, hot-rolled and annealed piping of similar composition."

After considerable additional test data has become available, it seems likely that the high-temperature design stress values established by the ASA and shown in Table 2 may in time be revised upward to be the same as applicable to static cast or even wrought chromium-molybdenum grades.

To date extensive use has been made of static sand cast fittings and valves of the 1¼ Cr – ½ Mo and 2¼ Cr – 1 Mo grades in even the most critical high-temperature power plant service. No adverse effects have been noted in these static castings. Certainly since properly made centrifugal castings represent a more dense product than static castings, there is no reason that centrifugally cast pipe products should not perform as satisfactory as wrought pipe in critical high-temperature service applications. It must be recognized also that wrought or forged steel is by no means a perfectly homogeneous material. In plate, pipe or other shapes these can contain laminations, surface slivers and other defects.

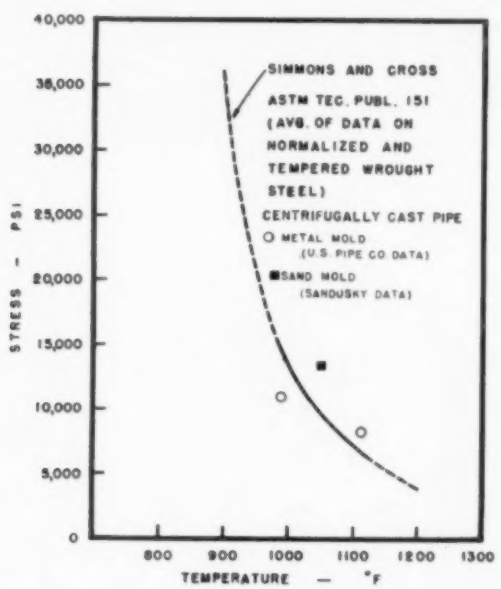

FIG. 10. Creep rate of 0.001 percent per hr (1 percent in 10,000 hr) of 2¼ Cr — 1 Mo piping materials.

As additional high-temperature test data are obtained and information on satisfactory long-time high-temperature service performance becomes available, the new proposed ASTM specification on Centrifugally Cast Ferritic Alloy Steel Pipe for High-Temperature Service is likely to become as important as the other recognized high-temperature piping specifications. This is a normal result of industrial progress and the constant search for alternate, newer, better or more economical materials.

MATERIAL COSTS

Price comparison of pipe produced by different or even the same methods tend to vary from manufacturer to manufacturer. The reason being that in some sizes one manufacturer can produce pipe more economically than another. An important factor to be considered also is pipe length, since with larger pipe sections the number of welds is frequently reduced. Where the pipe price per foot seems high, the availability of long sections may nevertheless reduce welding costs sufficiently to bring the cost of the complete piping assembly into line with initially cheaper pipe. Pipe with internal machining may also be more economically fit up and welded than extruded pipe.

Other factors to be considered are quantity purchased, uniformity, product quality, cleanliness, etc. Any comparison of the basis of price per foot alone can be misleading. Nevertheless, the above price ranges for seamless piping furnished to the three major applicable ASTM Specifications illustrate that centrifugally cast pipe can be significantly cheaper than the more conventional seamless pipe grades. ★ ★ ★

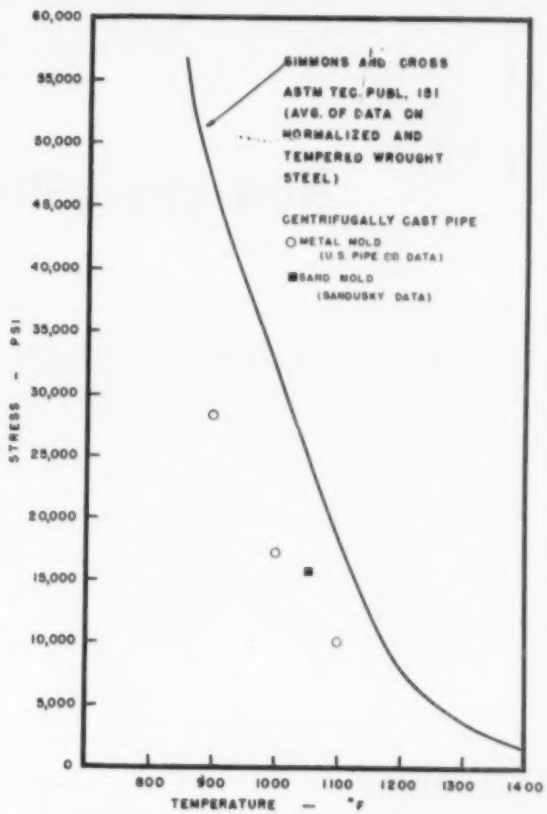

FIG. 11. Rupture in 1000 hr of 2¼ Cr — 1 Mo piping materials.

Pipe Material	Pipe Size OD in.	Pipe Size Wall in.	Pipe Specification	Length Available ft	Price per ft $
1¼Cr—½Mo	6⅝	1.10	Seamless A335	10—40	50— 95
			Forged and Bored A369	—	—
			Centrifugally Cast A426	7—20	45—120
	10¾	1.30	Seamless A335	10—30	70—110
			Forged and Bored A369	10—45	100—175
			Centrifugally Cast A426	7—20	65—125
2¼Cr—1Mo	10¾	2.40	Seamless A335	10—35	120—150
			Forged and Bored A369	15—45	120—220
			Centrifugally Cast A426	10—18	90—140
	20	4.40	Seamless A335	12—20	350—425
			Forged and Bored A369	15—45	330—500
			Centrifugally Cast A426	15—20	250—400

Now you can cut pressure vessel weight

The use of 299 tons of USS "T-1" Steel in these two Hortonspheres saved 216 tons of carbon steel and 42% in shipping costs. Designed and erected by Chicago Bridge & Iron Company for storing propane gas in Venezuela. These tanks were designed to the old code limits, but under the new code limits they could have been made up to 9.5% lighter.

Revisions in case 1204-4 of the ASME Code for boilers and pressure vessels increase maximum allowable stress value to 28,750 psi for "T-1" Steel. This permits further reductions in weight up to 9.5%.

even more with USS "T-1" Steel

The new figure of 28,750 psi represents an increase of 9.5% over the previous maximum allowable stress value of 26,250 psi which applied to USS "T-1" Constructional Alloy Steel used in pressure vessels. This means that USS "T-1" Steel can be used to reduce weight even more than it did before in stationary vessels or truck tanks.

The steel frequently used in welded, unfired pressure vessels is ASTM A-285-Grade C. This steel can be used with a maximum allowable design stress of 13,750 psi. From this, you can see that the allowable stress for "T-1" Steel is 2.1 times greater. To put it another way, plates of "T-1" Steel in a pressure vessel need be only half the thickness of A-285-C plates to withstand the same stress.

15% overall savings possible with "T-1" Steel

USS "T-1" Steel permits a 50% reduction in the amount of steel used in the vessel; this results in large savings in the cost of structural supports and foundations, welding, freight, handling costs and the elimination of stress relieving costs.

In a recent design, pressure vessels designed of both A-285-C steel and "T-1" revealed the following cost analysis:

	Use of "T-1"
Weight of steel	saved 50%
Cost of steel	only 20% more
Fabrication cost	saved 40%
Freight	saved 50%
Amount welding wire	saved 60%
Total savings	**15% cheaper overall**

These savings, plus USS "T-1" Steel's unique combination of toughness at low temperatures, high strength at elevated temperatures, and weldability, offer the pressure vessel designer the *only* material of this high strength level possessing *all* the qualities so important in the pressure vessel field.

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For Piping Design "Outside Battery Limits" . . .

API 5LX High-Test Line Pipe

ASA Standard B31.3-1959, "Petroleum Refinery Piping" permits the use of API 5LX pipe in the X42, X46 and X52 grades in refinery work

Gerald M. Haydel, *P. E., Frank H. Walk & Associates, New Orleans, Louisiana*

DURING the recent steel strike and resulting material shortage, several opportunities arose wherein availability of the high test line pipe posed the question of its possible substitution of A53 or A106 pipe. A thorough investigation of the properties of the API 5LX resulted. This article outlining proper application, methods of fabrication and economics of use is based on the study made in this regard.

ASA Standard B31.3-1959 "Petroleum Refinery Piping" permits the use of API 5LX pipe in the X42, X46 and X52 grades in refinery work except for highly flammable or toxic materials within the process unit limits.* Design conditions and criteria including allowable stresses for the X grade materials are listed in the ASA Standard. However, their use is not recommended under conditions where metal temperatures in excess of 300 F are encountered. A summary of recommended allowable stresses is given in Table 1. These are compared with similar allowable stresses for the A106 and A53 pipe in Fig. 1.

Design Considerations

Basically there appears to be no disadvantage in the use of the API 5LX high test pipe in outside battery limits application as long as metal temperatures below 300 F are maintained. The full range of normal refinery products and intermediates may be handled to and from storage and to truck, tank car or barge loading facilities. The pipe may be carried overhead, on low sleepers or below ground as required. Where the pipe is exposed to air it should be primed and painted in any one of the usual methods used for A53 or A106 grades and underground sections should be protected by precoating and joint wrapping methods generally considered acceptable for the other grades of pipe.

From a design consideration the X42, X46 and X52 pipe grades may be handled by usual stressing and support design methods with calculations based on the ASA allowable stresses listed in Table 1. Normal expansion loops, anchors, etc., may be used as required as long as material temperatures below 300 F are maintained. There is no apparent reason for concern about possible pipe or joint failure under normal expansion and contraction movements even with the thinner pipe walls in which the high test X grades are furnished.

To fully appreciate the importance of adhering to certain techniques in both shop and field fabrication and welding of the X grades of pipe, a study should be made of the chemical and tensile requirements for the manufacture of this material. Just as is the case with the A106 and A53 grades of pipe, the manufacturer develops the physical property requirements for the X grades by a combination of chemical composition control and physical working including cold expanding in some cases. Where the X grades are manufactured by the seamless method and are not expanded, a higher carbon and manganese content is required than when the cold expanded technique is used. Basically the chemical requirements for ladle analysis are the same for pipe manufactured by the welded method as for seamless pipe. Compared to the A106 grades, the API 5LX grades of pipe have a higher carbon and considerably higher manganese composition. The X46 and X52 grades run higher in carbon and manganese content than does the X42 grade, if the pipe is to be manufactured by the non-expanded method. Table 2 gives a comparison of the chemical requirements for ladle analysis of the X grades and grades A106 A and B.

Physical properties of pipe with which design engineers are basically concerned, and which are usually specified as

Table 1. Allowable Stresses for API 5LX Steel Pipe.* (Pounds per square inch)

Grade	Tensile strength Min., psi	Yield strength Min., psi	Metal temperature — deg F: −20 to 100	200	300
Seamless — X42	60,000	42,000	20,000	19,100	18,150
Seamless — X46	63,000	46,000	21,000	20,050	19,100
Seamless — X52	66,000	52,000	22,000	21,000	20,000
Seamless — X52	72,000	52,000	23,500	22,500	21,400
Welded — X42	60,000	42,000	17,000	16,200	15,400
Welded — X46	63,000	46,000	17,350	17,400	16,200
Welded — X52	66,000	52,000	18,700	17,850	17,000
Welded — X52	72,000	52,000	20,000	19,100	18,200

*Extracted from Petroleum Refinery Piping Code (ASA B31.3-1959), a Section of the American Standard Code for Pressure Piping, with the permission of the publisher, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, New York.

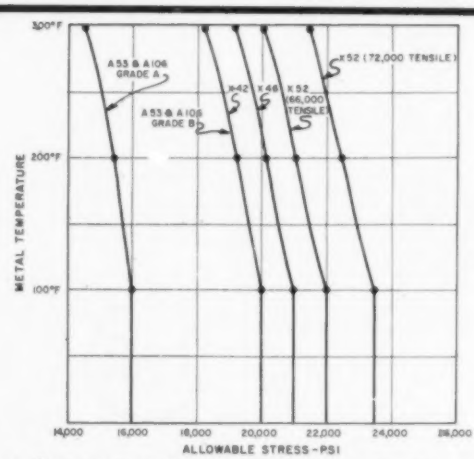


FIG. 1. Comparison of allowable stresses for seamless pipe.

*Paragraph 805.2(d).

the governing criteria in pipe purchases, must be understood when fabrication and welding of the X grades are considered. As the name indicates, pipe manufactured in accordance with API Specification 5LX has higher minimum yield strength than does ordinary line pipe. The designation X42 indicates a minimum yield strength of 42,000 psi, the X46 a minimum yield strength of 46,000 psi and X52 a minimum yield strength of 52,000 psi. Since the X grades are normally purchased on special mill orders in large quantities, and it is possible to specify and receive any minimum yield strength ranging from 42,000 through 56,000 psi, availability of the X grade pipe from inventories may be in any yield strength. However, the X42, 46 and 52 grades are the most common. Although the study mentioned earlier in this article gave consideration to high test pipe with yield strength in excess of 52,000 psi, more information was found concerning experience gained from actual usage for the X52 and lower yield strength categories. Some experience has been had with X56 grade. However, this has apparently been with larger diameter pipe and has been only within the past year. ASME paper 59PET-12 dated June 22, 1959 covers a report on the welding of X56 pipe in such an application. As might be expected with a high strength carbon steel, ductility has been sacrificed to gain high tensile strength. Elongation requirements for the 5LX grades are considerably higher than for A53 and A106 pipe. The minimum elongation requirement for X42 is determined by the formula E = 40t + 12.50, wherein E = percent elongation, and t = tabulated wall thickness of specimen in inches. For the X46 grade use the formula E = 48t + 8.00, and for the X52 grade E = 64t + 2.00. A comparison of tensile requirements between the 5LX grades and grades A106 and A53 are given in Table 3.

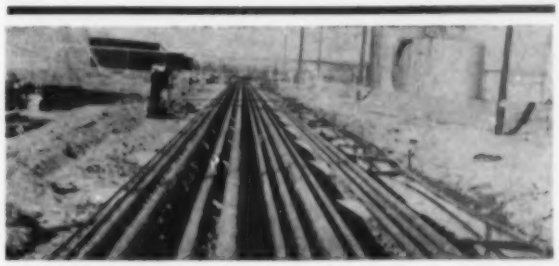


Table 2. Chemical Requirements for Ladle Analyses.

1	2	3	4	5	6
Process of manufacture	Grade	Carbon percent max.	Manganese, percent max.	Phosphorus percent max.	Sulfur, percent max.
SEAMLESS					
Electric-furnace or open-hearth:					
Non-expanded	X42	0.29	1.25	0.04	0.04
Non-expanded	X46, X52	0.32	1.35	0.04	0.05
Cold-expanded	X42, X46, X52	0.29	1.25	0.04	0.05
	A106 A	0.25	.27- .93	0.048	0.058
	A106 B	0.27	.29-1.06	0.048	0.058
WELDED					
Electric-furnace or open-hearth:					
Non-expanded	X42	0.28	1.25	0.04	0.05
Non-expanded	X46, X52	0.31	1.35	0.04	0.05
Cold-expanded	X42, X46, X52	0.28	1.25	0.04	0.05

Table 3. Pipe Tensile Requirements.

1	2	3	4	5	6	7	8
			Elongation in inches**, min., percent of tabulated wall thickness, in.				
Grade	Yield strength, min., psi	Tensile strength, min., psi	0.500 to 0.312, incl.	0.281	0.250	0.219	0.188
X42	42,000	60,000	25.00	23.75	22.50	21.25	20.00
X46	46,000	63,000	23.00	21.50	20.00	18.50	17.00
X52	52,000	66,000*	22.00	20.00	18.00	16.00	14.00
A106 A	30,000	48,000	35	33.25	31.50	29.75	28
A106 B	35,000	60,000	30	28.50	27	25.50	24
A53 A	30,000	48,000	35	33.25	31.50	29.75	28
A53 B	35,000	60,000	30	28.50	27	25.50	24

*For grade X-52 pipe in sizes 20 in. and larger, with wall thickness 0.375 in. and smaller, the minimum tensile strength shall be 72,000 psi.

**If the tabulated wall thickness is less than 0.312 in. and other than shown above, the minimum elongation requirement shall be determined by the following formula.

Grade	Formula	wherein
X42	E = 40t + 12.50	E = percent elongation
X46	E = 48t + 8.00	t = tabulated wall thickness of specimen in inches
X52	E = 64t + 2.00	

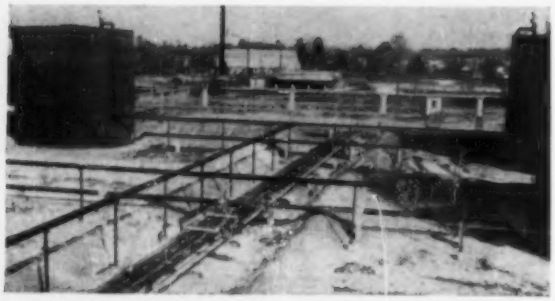
Fabrication

Satisfactory results have been secured in manual field welding of API 5LX pipe with the use of normal electric arc methods, rods and equipment, and without the use of preheating under normal climatic conditions. However, best experience indicates that consistent good results can be assured only if special consideration is given to welding methods and welders' qualifications. The high carbon-high manganese content of the X grades tends to produce brittleness and cracks in areas immediately adjoining welds. This hazard can be eliminated by preheating and by use of special welding rods particularly where welding of wall thickness less than .25 in. is involved. Where hand welding is to be used, best results can be secured by preheating the pipe in the area of the weld to a temperature of 150 F, and by making all weld passes "vertical up" with a coated rod meeting AWS Specification E-7010. This method is a practical must for the thinner wall pipe. Where larger pipe diameters and heavier wall sections are encountered, the following combination may be used.

Pass	Rod Size, in.	AWS Class	Typical Manufacturer's Classification
Stringer bead	5/32	E-6010	Fleetweld 5P
Hot pass	5/32	E-7010	Shield Arc 85
Filler pass	3/16	E-7010	Shield Arc 85P
Stripper pass	3/16	E-7010	Shield Arc 85P
Cover pass	3/16	E-7010	Shield Arc 85P

Even with the thinner walls, ranging from .118 to .219 in., a minimum of three to four welding passes is recommended depending on fit-up. Automatic welding of fittings, etc. may be successfully accomplished in the shop using a No. 760 or No. 840 flux in combination with an L-60 electrode wire. Root passes on such buttwelds should be accomplished by hand using a Fleetweld 5P rod. Preheating should be accomplished prior to welding.

Gerald M. Haydel, *a partner in Frank H. Walk & Associates, has been responsible for the engineering design of numerous refinery off-site piping projects in the Gulf Area. His previous associations include Texaco Inc. at Port Arthur, Texas, Pan Am Southern Corporation at Destrehan, Louisiana, and Truman B. Wayne & Associates in New Orleans. He is a registered professional engineer.*



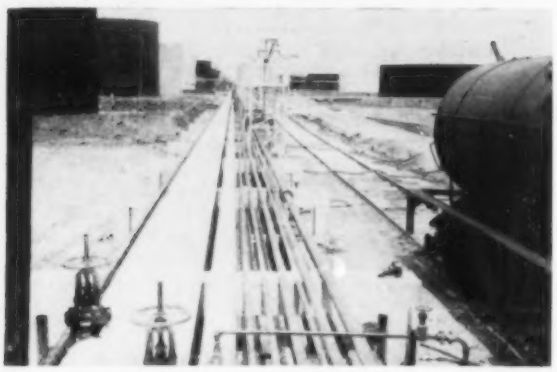


Table 4. Cost Comparison — A106 Pipe vs API 5LX Pipe.

Case No.*	Pipe size, in.	Pipe specification	Pipe grade	Wall thickness, in.	Price per 100 ft
1	6	ASTM A 106	B	.280	$174.72
		API 5LX	X-46	.219	$144.90
2	8	ASTM A 106	B	.277	$225.62
		API 5LX	X-46	.219	$188.65
3	10	ASTM A 106	B	.307	$315.00
		API 5LX	X-46	.250	$270.20
4	12	ASTM A 106	B	.375	$455.03
		API 5LX	X-52	.312	$408.62
5	14	ASTM A 106	B	.375	$490.50
		API 5LX	X-46	.312	$440.04

*Comparisons based on selection of pipe in each class to withstand combined stresses imposed by given conditions.

Welder Qualification

With regard to welders' qualification, close adherence to API Standard 1104, 3rd edition, dated March 1955, is recommended. For testing of specimens prepared for the X grades a longer bend radius is permitted than is the case for low tensile pipe. A jig design for these guided bend tests is available upon request.*

Costs

Due to their higher yield strength the X grades may be used in thinner wall sections than could A53 or A106 pipe for similar line pressures and other stress producing conditions. Table 4 gives a comparison of pricing costs between the A106 and X grades for several typical applications. For initial installations higher unit labor costs can be anticipated for the X grades due to the preheat requirements, although with certain climatic conditions preheating would be necessary with low tensile pipe as well. Once experience is gained and confidence assured any difference in labor costs for welding of the X grades (X42, X46 and X52) should be reduced to a negligible amount. Weld type fittings are readily available for the most part to match the material and wall thicknesses of X grade pipe. Under certain supply conditions these will be found to be higher in cost than the standard low tensile fittings, however, when the opportunity for use of thinner wall sections is considered a net savings should result on fitting costs for most applications.

Some mention has been made in the foregoing about pipe manufactured to the API 5LX specification with minimum yield strength of 56,000 psi. Although these grades are now being used extensively by the gas transmission companies for cross country pipe line work with satisfactory results it is generally believed that such steels have reached the upper limits of weldability. Considering this, and the additional precautions and close controls necessary for welding, particularly welding by manual means, it is considered inadvisable to use high tensile pipe in grades higher than X52 for petroleum refinery work at this time. Doubtless cases will be found wherein conditions will be such as to wisely permit the use of X56 pipe for off-site applications with considerable savings in overall costs. These will be found for the most part where line sizes exceeding 20 in. in diameter are involved.

In summary it is well to recall that high test line pipe was developed specifically for use in overland gas and oil transmission lines. In recent years it has replaced practically 100 percent the use of low tensile API 5L pipe in such applications, its use will unquestionably continue for such lines because of the higher strength of this material which permits a substantial reduction in wall thickness which in turn affords substantial savings in material costs.

These higher tensile steels differ appreciably in chemical and physical properties from the low tensile A53 or A106 grades, which we are extensively using for refinery work. The high test X grades of pipe, however, can be successfully used in refinery offsite work if selected application is made. In times of shortage, overall economic considerations can well extend the range of practical and economic applications for the X grades of pipe in refinery work. However, under normal material supply conditions there are many cases where the X grades may be used advantageously. ★

*Send requests to Editor, *Refining Engineer*, P. O. Box 1589, Dallas 21, Texas.

Pentafining

Licensed by: The Atlantic Refining Company

DESCRIPTION: This catalytic process converts normal pentanes or normal hexanes to their respective isomers. Since the isomers are higher in octane rating than the normal compounds, the process may be used either for octane improvement or for specific isomer production.

Feedstock is mixed with a recycle hydrogen stream, heated to reaction temperature and pressure, and passed over a fixed bed of Pentafining catalyst, where isomerization takes place. After cooling and condensing, light ends are fractionated out, after which isomer is distilled from the mixture.

Unconverted normal compounds, together with normal components in fresh feed are recycled back to the reactor.

Pentafining catalyst, developed by The Atlantic Refining Company, is a platinum on silica-alumina material.

TYPICAL ONCE-THROUGH YIELDS:

Feed Stock	n-Pentane		n-Hexane	
Yields	Wt. %	Vol. %	Wt. %	Vol. %
Methane	0.1		0.1	
Ethane	0.1		0.2	
Propane	0.1		1.2	
Isobutane	0.1		0.2	
n-Butane	0.6		0.3	
Isopentane	58.9	59.5	0.1	68.0
n-Pentane	39.6	39.6	0.9	29.5
Isohexanes	0.5		67.3	
n-Hexane			29.5	
C_7 and Heavier	0		0.2	
Total	100.0	99.1	100.0	97.5
C_4 and Lighter, Wt. %	1.0		2.0	
Isomers in Products, Vol. %	60.0		70.0	

SERVICE FACTOR: 95 Percent

CHEMICALS AND CATALYSTS:

Catalyst Inventory: 1-2 lb per BPD
Catalyst Consumption: 0.015-0.005 lb per B
Chemicals Consumption: Nil

OPERATING MANPOWER: One man per shift

INVESTMENT: $300-$500 per BPD, including fractionation.

UTILITIES: Per B Feed*

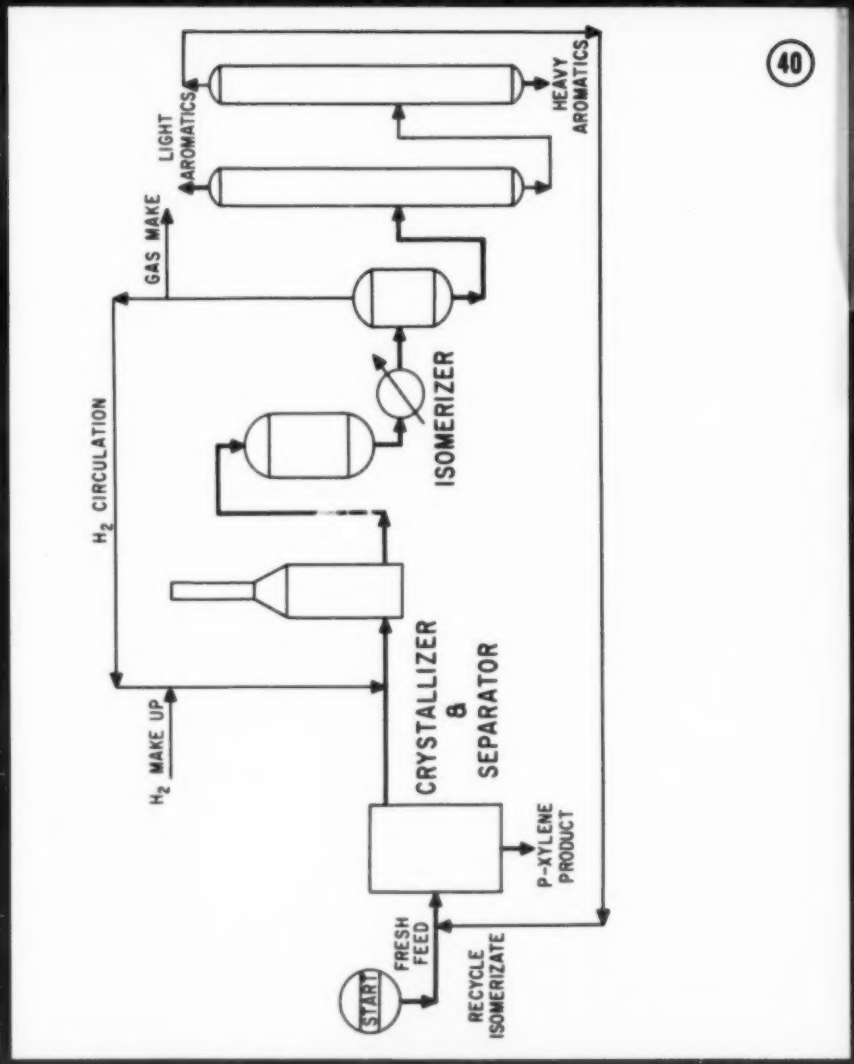
Steam @ 400 psig	19 lb
Power	3.3 kw
Cooling Water	114 gal
Fuel	720 M Btu

*Feed assumed to contain 50% n-C_5

MAINTENANCE COSTS: About 2½ percent of investment annually.

Octafining

Developed by: The Atlantic Refining Company
Licensed by: Engelhard Industries, Inc.



Octafining

Developed by: The Atlantic Refining Company
Licensed by: Engelhard Industries, Inc.

DESCRIPTION: The Octafining process operates on mixtures of C_8 aromatics, (ethyl benzene, ortho-, meta- and para-xylenes) to bring their concentrations toward an equilibrium value. Therefore, the quantity available of any one of the four can be increased by charging to the Octafining process a mixture of C_8 aromatics in which the concentration of the desired one is below the equilibrium value for it in the mix. An example of a practical application, is to maximize para-xylene yield from a mixed C_8 aromatics feed which otherwise would have only a solvent value. In this application, the C_8 aromatics from catalytic reforming and as recycle from the Octafining process would have p-xylene removed by crystallization, to give a filtrate containing 7-9 percent p-xylene. This filtrate would be mixed with recycle hydrogen and some make-up hydrogen, heated to 750-950F at 150-350 psig and passed through Octafining catalyst in the single reactor. Isomerization within the Octafining reactor brings the p-xylene content back to its equilibrium value of about 19 percent. Following the Octafining reactor, the isomerizate is cooled, hydrogen separated for recycle and aromatics below and above C_8 removed by fractionation. The remaining C_8 mixture is recycled to join fresh feed ahead of the crystallization. If it should be desired to maximize ortho- or meta-xylene, a separation step appropriate to the desired isomer would replace the crystallization which in the above example was used to separate the para-xylene.

Atlantic's laboratory work indicates that the Octafining catalyst can be used also on C_9 aromatics to isomerize cumene into trimethylbenzene and methylethylbenzene under appropriate operating conditions. The Octafining catalyst contains platinum on a silica-alumina support.

SERVICE FACTOR: Octafiner 94 percent; including p-xylene crystallizer approximately 92 percent.

UTILITIES AND OPERATING COSTS (basis 30,000,000 lb per year of p-xylene product 98 percent purity):

Heat to oil — million BTU per hour	26
Compressor brake horsepower	620
Power for pumps & lighting — KW	48
Cooling water circulation — GPM	1590
Catalyst cost, dollars per calendar day	280
Operating manpower, per shift	2
Maintenance — Percent of initial investment cost per year	4

INVESTMENT (same basis as Utilities & Operating Costs):

Includes Octafiner reactor, isomerizate fractionation and first catalyst charge, but not crystallizer: $1,350,000.

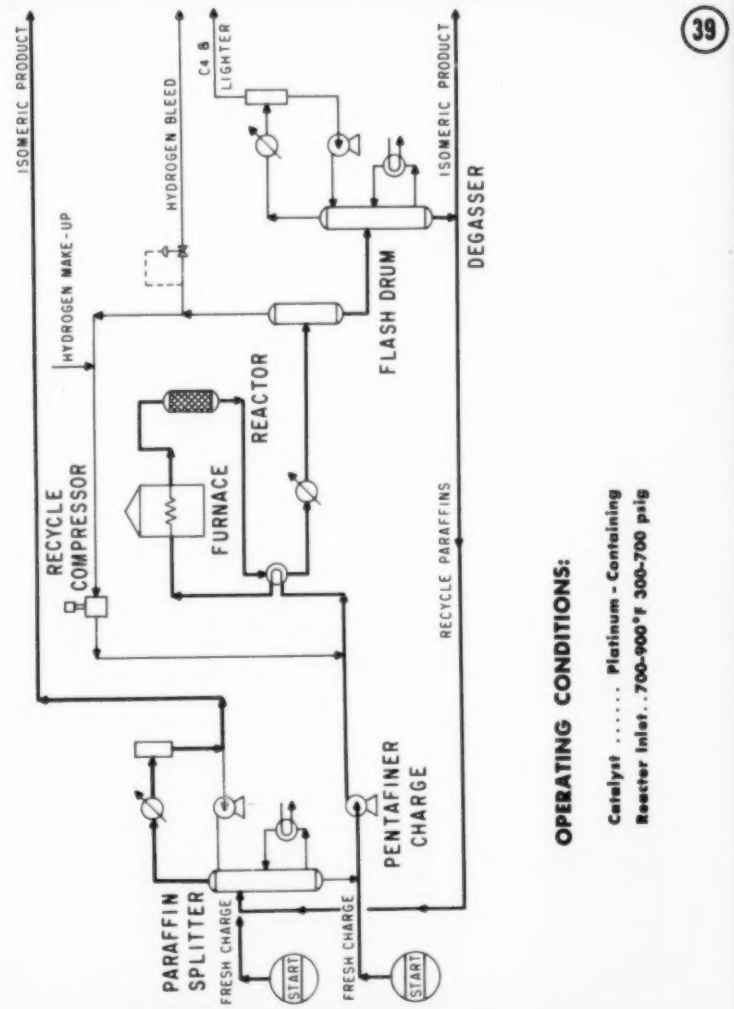
OVERALL MATERIAL BALANCE (same basis):

	Fresh Feed		p-x Product		By-Products	
	Wt. %	Million lb/yr	Wt. %	Million lb/yr	Wt. %	Million lb/yr
C_3 and lighter paraffins	—	—	—	—	26.3	3.6
C_4 and heavier paraffins	1.3	0.6	—	—	—	—
Benzene	—	—	—	—	15.3	2.1
Toluene	1.6	0.7	—	—	27.7	3.8
Ethyl Benzene	16.0	7.0	—	—	—	—
Para-xylene	17.6	7.7	98.0	29.4	—	—
Meta-xylene	38.0	16.6	2.0	0.6	—	—
Ortho-xylene	23.4	10.2	—	—	—	—
C_9 and heavier aromatics	2.1	0.9	—	—	30.7	4.2
	100.0	43.7	100.0	30.0	100.0	13.7

COMMERCIAL APPLICATION: An Atlantic Octafiner is being built for Mitsui Petrochemical Industries, Ltd. In conjunction with a crystallizer, it has a rated capacity of 11,000,000 lb of p-xylene per year.

Pentafining

Licensed by: The Atlantic Refining Company



OPERATING CONDITIONS:

Catalyst ..... Platinum - Containing
Reactor Inlet..700-900°F 300-700 psig

Here are some of the...

Low Temperature Characteristics of Metals

Unusual problems are created by low temperature operation and here is a discussion of some of the common metals and methods of fabrication used to combat this problem

O. A. Hansen, *Linde Company, Division of Union Carbide Corporation, Tonawanda, New York*

CHARACTERISTICS of all materials of construction are affected by temperature, and it is part of the work of the engineer to select those materials suitable for the conditions of operation. But, reliability of the complete apparatus depends upon more than proper material. Treatment of that material before fabrication, methods of fabrication, and test procedure all leave a marked effect on the finished article.

Crystal Lattice Structure of Metals

The metallurgist provides a convenient grouping of metals by classification of the crystal structure, according to the arrangement of the atoms in the crystal. Three arrangements are shown in Fig. 1, and those metals of a common lattice structure show generally the same reaction to low temperature. That is, those metals which have a cubic lattice with an atom in the face of each surface show no loss of ductility at low temperature, but those which are "body centered" show a marked tendency to brittleness at temperatures below a "transition range." Curves of ductility versus temperature for body centered metals are generally "S" shaped, with a nearly vertical drop of ductility at some narrow temperature range. This range is called the transition temperature or transition range. The hexagonal lattice metals are similar to the body centered materials except that the transition temperature is well above room temperature. For low temperature work, then, the material behaves as if it had no transition temperature range. The ductility for several metals, as indicated by the notched bar impact value, is shown in Table 1.

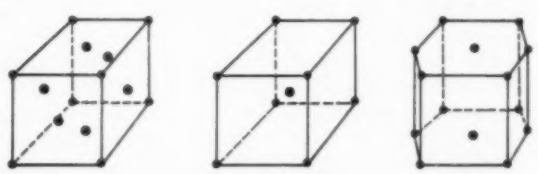


FIG. 1. Lattice structure of metal crystals.

TABLE 1. Notched Bar Impact Values.

		Energy to Break — Ft-lb	
Metal	*Crystal Lattice*	*at Room Temp.*	*at –320 F*
Aluminum	Face Centered Cubic ...	19	27
Copper	Face Centered Cubic ...	43	50
Nickel	Face Centered Cubic ...	89	99
Iron (Armco)	Body Centered Cubic ...	78	1.5
Titanium	Hexagonal	14.5	6.6
Magnesium	Hexagonal	4	(3 at –105F)

It will be noted that the ductility of the face centered metals improves at low temperatures, while that for iron falls to a very low value. Fortunately, iron can be alloyed so the reduction of ductility is not so severe.

Face Centered Lattice Materials

The most widely used material for early low temperature work was copper. Its formability and ease of making joints with soft solder made it a natural metal for construction of experimental equipment, and that experience was carried out into the commercial field. Large commercial equipment emphasized the drawbacks of low strength and the unreliability of the soft soldered joints.

The strength of copper was increased considerably by alloying, as for example, to obtain the 3½ percent silicon alloy. Effect of this alloying is shown on Table 2, the values being for the annealed state.

Values given in Table 2 are for room temperature, and reduced temperatures tend to improve the properties of the alloys to about the same extent as the base metal.

TABLE 2. Properties of Silicon-Bronze Alloy and Copper.

Property	*Alloy*	*Pure Copper*
Ultimate strength—psi	62,000	33,000
Yield point psi—0.5% offset	21,000	8,000
Elongation—% in 2 in.	72	50
Reduction of area—%	75	65
Thermal conductivity Btu/hr/ft/F ..	27	227

Adapted from a paper presented by the author at the 14th Annual Petroleum Mechanical Engineering Conference, Houston, Texas, September 1959.

Increasing production facilities and a lowering price schedule has made aluminum a much more widely used material for low temperature service. In its pure state, it has easy working characteristics, but it is not very strong. Alloys of aluminum are being developed with improved physical properties and retain most of the easy working features of the pure metal. Table 3 shows the physical properties of one of the new alloys for which the ASME Code has established the design stress.

TABLE 3. Properties of Aluminum Alloy and Aluminum.

Property	5083 Alloy	Aluminum 3S	Aluminum 2S
Ultimate strength	45,400	15,600	9,500
Yield point psi—0.2% offset	21,800	6,000	2,500
Elongation—% in 2 in.	23	43	25
Reduction of area—%	35	81	
Thermal conductivity Btu/hr/ft/F	60	92	103

As for the case of copper and its alloy shown on Table 2, these values are for room temperature conditions, but the physical properties are not changed much by a reduction of temperature, except generally to "improve" them.

It will be noted that alloying both copper and aluminum reduced the thermal conductivity — by a factor of 8½ to 1 for copper-silicon alloy and nearly 2 to 1 for 5083 alloy compared to pure materials.

Aluminum alloys have long been attractive for fabrication of equipment for low temperature. All the alloys as well as pure aluminum are ductile at low temperatures; and, in addition, they are non-corrosive and easy to fabricate. Aluminum alloys have not been used, in large amounts, until the last decade because the low strength of the available alloys kept them from being economically competitive. For most pressure vessel work, alloys must be weldable; and until recently, the strongest weldable aluminum alloy had an ultimate strength of only 25,000 psi. Since these alloys were one-third as heavy as stainless steel, and only one-third as strong, and approximately the same cost on a weight basis, there was not much to gain in their use. In addition, heavier gages required with aluminum increased welding costs considerably. Another deterrent was the need for developing proper procedures for welding.

There are now standard procedures including welder training, and rigid control on cleaning procedures and weld design which ensure sound joints. Also, the development of new alloys such as 5154, with ultimate tensile strength of 30,000 psi makes the picture more favorable. Newer alloys with 40,000 and 42,000 psi ultimate strength further brighten the future of this metal.

The fatigue limit of all aluminum alloys when welded is only 5000 to 10,000 psi after a few million cycles.

Austenitic stainless steels are a good example of a face centered cubic system alloy. If these steels are kept in the austenitic state by proper heat treatment and composition, (for example, low carbon content) they are excellent at low temperatures. The low temperature toughness of the base metal may drop if the metal is cold worked, or if the carbides have separated because of improper heat treatment. Even under somewhat adverse conditions, the toughness is comparatively high with Charpy impact values of 30 to 50 ft-lb.

Toughness of stainless steel welds is normally much lower than that of base metal, and constant effort must be used to ensure welds of satisfactory ductility. For this reason, alloys having high carbon content such as the AISI 302 steel is not used. The 347 stainless steel is not quite as bad, but the toughness of its welds is borderline, so it has limited use in welded equipment. Welds in 304 stainless steel are heat sensitive and are deleteriously affected unless the proper filler metal is used. For example, if post weld heating is encountered, as from a brazing process, the Charpy keyhole toughness of a standard 308 electrode weld may drop to as low as 5 to 10 ft-lb. This effect is even noticed

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Mr. Hansen is a graduate of Worcester Polytechnic Institute with the BS degree in mechanical engineering. He is a member of Tau Beta Pi, Sigma Xi and Union Carbide Corporation Engineering Liaison Committee. He is also a member of the Society of Automotive Engineers, a licensed Professional Engineer in New York and a member of the Society of Petroleum Engineers.

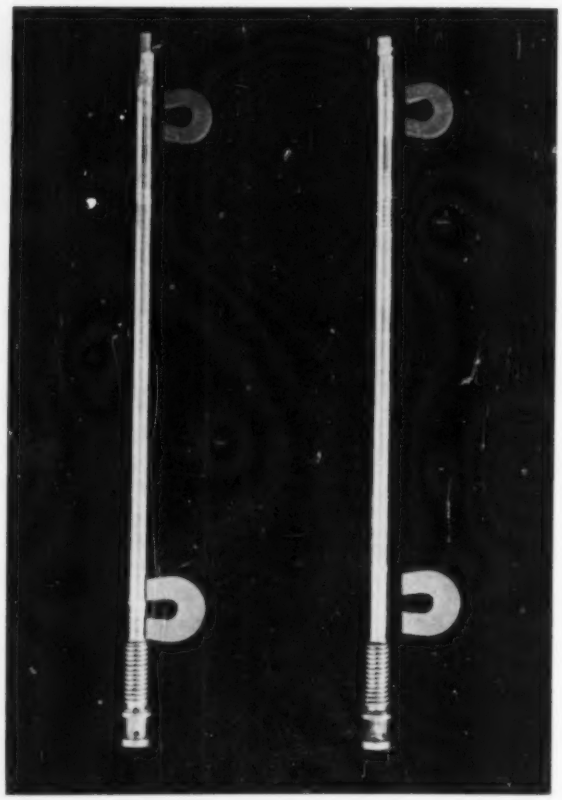


FIG. 2. The martensitic transformation of austenitic stainless steel is exhibited the magnetic properties of the cold end.

in multiple pass welds where earlier welds are affected by the latter.

It is evident from the foregoing that stainless steel structures should not be stress relieved in the carbide precipitation range of 850 F to 1600 F. Little value is obtained below 850 F, and distortion and improper cooling may be encountered at the higher temperatures.

There is interest regarding the transformation of the austenitic stainless steel to the martensitic form after prolonged exposure to very low temperatures. There is no question but that some transformation does occur. Fig. 2 shows the stem of a valve which had been in liquid oxygen service for several years. One end of the stem had been at room temperature all the time, and showed no magnetic properties, while in the cold end there was sufficient martensite to hold the magnet as shown on the photograph.

While this photograph is proof that there is some conversion to martensite by prolonged exposure to low temperature, we know of no failures which can be attributed to this conversion. Samples taken from tanks which have been in service a dozen years or more show no reason to consider the austenitic stainless steels other than "everlasting" in low temperature service. It is believed that a combination of time, low temperature, and plastic flow are required for martensite conversion. Even where there is appreciable conversion, as shown by microphotography, there is no great loss of ductility.

Body Centered Lattice Materials

Iron and steel are the most common materials of this group, and are the most generally used construction materials. However, the material must be specially alloyed for use at low temperatures, and for most applications, the alloying must be extensive.

These materials have a transition range wherein the material changes from ductile to one which is markedly notched sensitive and which fails with a brittle fracture. The strength increases at low temperature, but the notch sensitivity is such that the performance at temperatures below the transition range is generally unpredictable. If there was complete assurance that the material is free of notches and stress raisers, the high strength of low alloy steel might be used effectively even at very low temperatures.

An example of satisfactory use of low alloy steel at very low temperature is found in wires used in prestressed concrete for large liquid oxygen storage tanks. The wire which is wrapped around the concrete tank is 0.162 in. diameter, cold drawn to 0.142 in. during application. This imposes a stress of 140,000 psi in the wire.

When drawn to 0.142 in. diameter, the wire has a tensile strength of 230,000 psi at room temperature and 300,000 psi at liquid oxygen temperature. Although the elongation is only about 2 percent in 10 in. at liquid oxygen temperature, several test specimens have been bent at over 90 deg before fracture.

General effect of the alloying of various amounts of nickel with steel is shown in Fig. 3. It will be noted that the transition range moves to lower and lower temperatures with increasing nickel content, and that residual ductility is somewhat higher. When nickel content is raised to 8.5 percent, however, transition temperature drops below −320 F, and the alloy has characteristics quite unlike the lower alloys. It becomes a material quite well suited for low temperature work, but there may be some unusual problems encountered in its use.

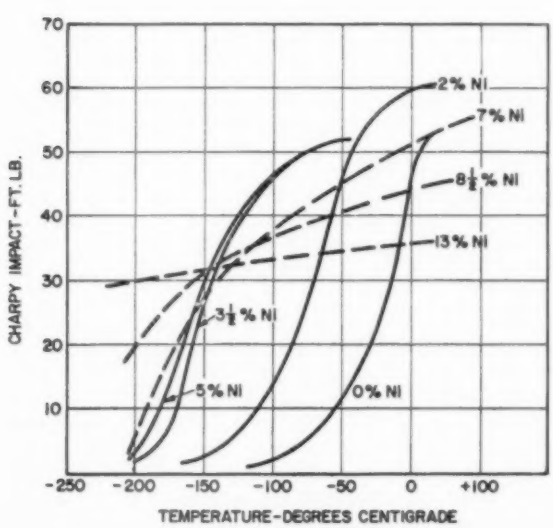


FIG. 3. Impact strength of nickel steel.

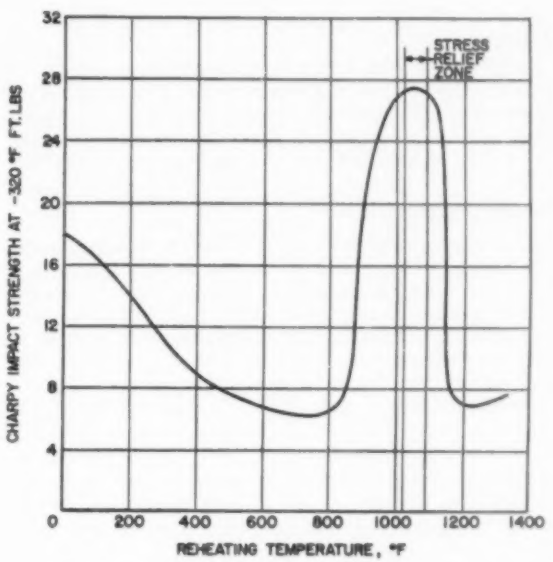


FIG. 4. Effect of reheating on impact strength of SA-353 steel at −320 F.

Nine percent nickel steel is specified as SA-353 and has an allowable working stress of 22,500 psi except where the weld metal stress is limiting. Welds made with Inco Rod A have tensile strength of 109,000 psi and yield strength of 70,000 psi. The finished vessels must be reheat treated by stress-relieving at between 1025 F and 1085 F for two hours or more, depending on the thickness. The effect of the stress relieving on the Charpy impact strength is shown on Fig. 4.

Cast iron is an interesting material at low temperatures. It has very little ductility at room temperature, and loses about half of that at low temperature. It has been explained that this is because the material, with its many graphite inclusions, is so full of notches that the effect of extraneous notches goes unnoticed. Addition of nickel as an alloying element permits cast iron to retain more of its ductility at

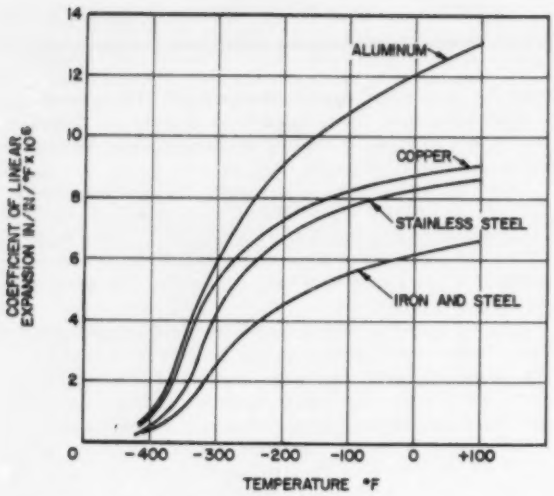


FIG. 5. Linear coefficients of expansion.

low temperature. Many cast irons show a tendency to increase in volume after being subjected to very low temperature.

In using cast iron, the safety factor may be about 40 to 1. The code does not specify minimum impact strength if the factor is more than 20 to 1. There are data to show that a crack cannot be initiated or propagated even in brittle material if the stresses are low — below 6000 to 10,000 psi.

Piping Flexibility

Changes in material characteristics can introduce many new variables in the computations for stresses which occur because of reduced temperature. The modulus of elasticity increases somewhat at low temperatures, but the effect is not serious because the thermal expansion is reduced at very low temperatures. Fig. 5 shows the reduction of the thermal expansion for a number of materials.

There is another factor, however, which must be taken into consideration. That is that low temperature equipment is usually constructed at the midpoint of the temperature range, the material being heated after fabrication for drying, before being subjected to low temperature operation. This makes it impossible to use "cold-springing" at room temperature to limit the maximum stress at the operating temperature.

Solders

As mentioned earlier, the first low temperature equipment was usually made of copper with soft solder (50-50 lead-tin) joints. Availability of copper in tubing form extended its use for piping long after the pure copper had been superseded by alloys or other metals for the pressure vessel components, and it was natural that soft solder would be continued for use at the joints. Low strength of the solder was easily compensated for by making the mating parts overlap an appreciable distance. However, the 50-50 lead-tin solder has a temperature transition similar to that for iron so at low temperatures the solder is brittle. Long periods of operation under high longitudinal stress imposed by contraction at low temperature causes some soft soldered slip joints to "creep." Instances have been found where the "creep" would be in the order of ⅛ in., but the joint would be still leak tight.

Development of high strength copper alloys which could not be soft soldered led to improved silver solder and brazing techniques. This has been carried to the point where the soft soldered joint for low temperature work may be considered obsolete.

Copper-silicon-bronze alloys can be readily joined by welding or by silver brazing. Some relatively low melting solders can be used, but even these require heating to the point where the bronze parts are annealed, so the annealed condition must be assumed for all soldered or welded parts. The very low thermal conductivity of the material, however, localizes the heating at and very near the joint so the improved characteristics of work hardened piping, for example, can be utilized in part. In this case, the confinement of the heat softened zone permits some overstressing beyond that permitted for fully annealed material.

A simple, but major item, in the development of the hard solder joint in piping was the establishment of a short overlap. When the fittings used for soft solder connections are used with silver brazing, either the joint is overheated or the joint contains a trap. With an overlap of only ¼ in. to ⅜ in., the silver solder can be "flowed through" to make a pocketless joint without burning the piping. The presence of a pocket can lead to failure as it might contain and retain a small amount of water, which upon repeated freezes and thaws will progressively wedge the joint open.

An early source of much trouble was the lead content of many of the cast fittings used for soft soldered piping. Silver brazing on these fittings would not be successful because the lead would separate and contaminate the brazing alloy and result in cracking.

Aluminum to Stainless Steel Joints

Morton C. Smith and David D. Rabb present, in the Proceedings of the 1959 Cryogenic Engineering Conference, the description of four joining methods, namely:

1. Copper-Plated Aluminum to Stainless Steel.
2. Ultrasonic-Tinned Aluminum to Stainless Steel.
3. Frictioned-Tinned Aluminum to Stainless Steel.
4. Aluminum to Copper to Stainless Steel.

These procedures are aimed at means of tinning the aluminum so that a subsequent soldering operation can be carried out between two compatible metal surfaces. In all cases, the solder is subjected to severe stresses by any change in temperature because of the extreme difference in thermal expansion of the two base metals. If the solder layer is too thin, there is so much resistance to flow that the stresses may be extreme. If the solder layer is thick, it may present problems because of its own inherent weakness. Use of a mechanical joint to relieve the solder from stress with the solder acting as a seal makes a satisfactory arrangement.

Several new methods are being developed to join aluminum to other metals. The refrigeration industry uses flash welding of copper and aluminum tubes. The Al-Fin process casts a layer of aluminum on a "pre-tinned" part made of some other metal. The commercial product, copper clad aluminum, can be used as an intermediate part, with aluminum welded to the aluminum part and copper or steel to the other part. It is necessary in this case to strip the opposite metal from the area near the joint to prevent weld or braze contamination. ★ ★ ★

Here is a guide
for the selection of...

DESIGN MATERIALS FOR SERVICE < 0° F

Milo Palmer
Chief Design Engineer, J. F. Pritchard & Co., Kansas City, Missouri

THE RAPID EXPANSION in the use of processes in which sub-zero service temperatures are encountered, have brought about an urgent need to know about the behavior, relative costs, material availability and mechanical design and safe guards concerning the use of ferrous and non-ferrous materials in these services. It is, therefore, the purpose of this article to present in general terms, some materials of construction, and to discuss the mechanical design of piping and equipment in rather broad terms.

Engineering tests on ferrous materials have provided information to show that, as the temperature of the material decreases from room temperature (except for those highly brittle materials) the hardness, yield, fatigue and tensile strength increases. It is also shown by test, that the ductility and the amount of energy absorption before fracture decreases. It is with these latter two properties that we are most interested in the selection of materials for construction for processes that operate at sub-zero service temperatures.

Adapted from a paper presented by the author at the 14th Annual Petroleum Mechanical Engineering Conference, Houston, Texas, September, 1959.

TABLE 1.

Service Temperature	Material
0 F to minus 20 F	Carbon Steel
Minus 20 F to minus 50 F	Carbon Steel Aluminum Killed
Minus 50 F to minus 150 F	Alloy Steel
Minus 150 F to minus 320 F	Alloy Steel or Non-Ferrous

TABLE 2. Relative Cost of Pipe Material.

Material	A.S.T.M. Spec. No.	Cost of Pipe	Service Temp. F
Ferrous			
Carbon Steel			
Plain	A53 Gr. A	1.00	— 20
Killed (Alum.)	A106 Gr. A	1.10	— 40
Killed	A333 Gr. C	1.91	— 50
Alloy Steel			
Ferritic Type			
3½% Ni	A333 Gr. 3	3.33	—150
5% Ni	A333 Gr. 5	3.92	—150
8½% Ni	To A333	5.83	—320
Austenitic Type			
18% Chrom 8% Ni	A312-TP304	8.76	—320
18% Chrom 8% Ni	A312-TP316	14.06	—320
18% Chrom 8% Ni	A312-TP321	10.10	—320
18% Chrom 8% Ni	A312-TP347	12.81	—320
25% Chrom 12% Ni	A312-TP309	12.05	—320
25% Chrom 20% Ni	A312-TP310	17.09	—320
Non-Ferrous			
Brass	—	4.47	—320
Copper	—	4.59	—320
Aluminum	6061-T6	1.47	—320
Aluminum	3003	1.28	—320

Materials

Materials for sub-zero service may be classified as to service temperature as shown in Table 1.

For any given material there are external and internal conditions which affect the embrittlement. Presence of surface blemishes and deep notches, and the simultaneous action of a high rate of straining, a non-uniform stress distribution, a tri-axial state of stress and low temperature are some of the external conditions affecting embrittlement. Some internal conditions affecting embrittlement are chemical inhomogenities, discontinuities and cracks, grain size variations, structural inhomogenities, residual stress, strain hardening or cold working and state of deoxidation.

Use of rimmed or semi-killed steels should be used with caution in those conditions where shock loading may occur at room temperatures and below.

In Table 2, the division of temperatures and materials are arbitrary and could be changed, as the following discussion will show.

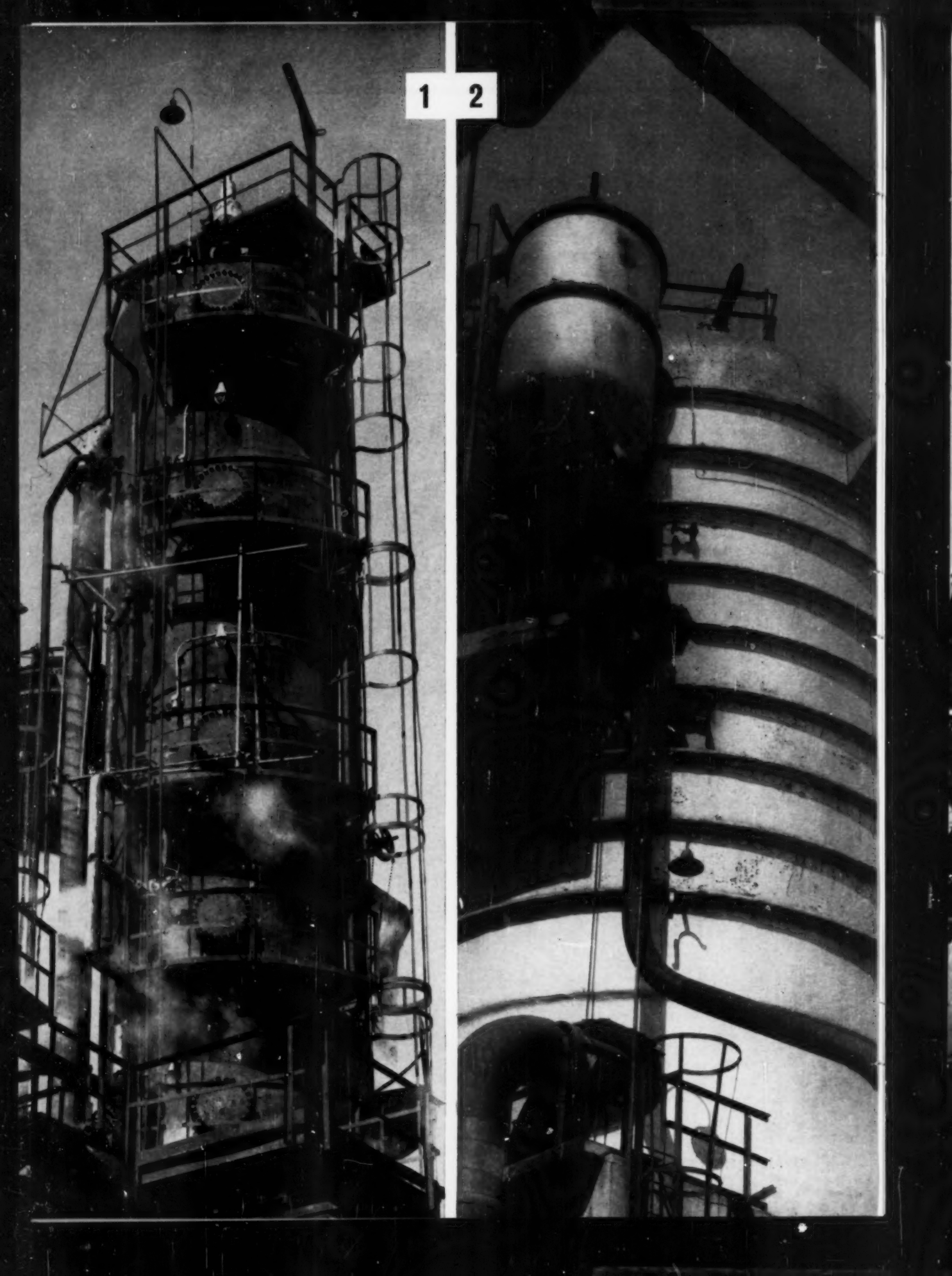
In most steel making processes the principal reaction is the combination of carbon and oxygen to form a gas. If the oxygen available for this reaction is not removed prior to or during casting (by the adoption of a deoxidizer) the gaseous products continue to evolve during solidification. If practically no gas is evolved the steel is termed killed. Increasing degrees of gas evolution results in semi-killed, capped or rimmed steels.

Killed steels have a more uniform chemical composition compared to other types; there are however, some variations from surface to center and from top to bottom. Killed steel is a type in which there is only a slight evolution of gases during solidification of metal after pouring into moulds. Deoxidizing is usually done with silicon or aluminum. Alloy and stainless steels are always produced as killed steels.

Semi-killed steels are characterized by variable degrees of uniformity and have properties intermediate between killed and rimmed steels.

Rimmed steels are characterized by marked differences in chemical composition across the section from top to bottom of the ingot. They have an outer rim that is lower in carbon, phosphorous and sulfur than the average composition of the whole ingot and an inner portion or core that is higher than the average in those elements. Typical structure of the rimmed steel ingot results from a marked evolution of gas during solidification of the outer rim. Satisfactorily rimmed steels do not retain any significant percentages of highly oxidizable elements such as aluminum, silicon or titanium.

From the above, it is understandable that rimmed steels show a very wide energy absorption at room temperature and because of this they should not be used in low temperature service. For shock loading they should be limited to probably 70 F, however, for non-shock or steady-state loading they could be used for minus 20 F service. Semi-killed steels are improved over the rimmed steels and can be used for service to minus 20 F without difficulty, except in severe shock service. Fully killed steels such as aluminum killed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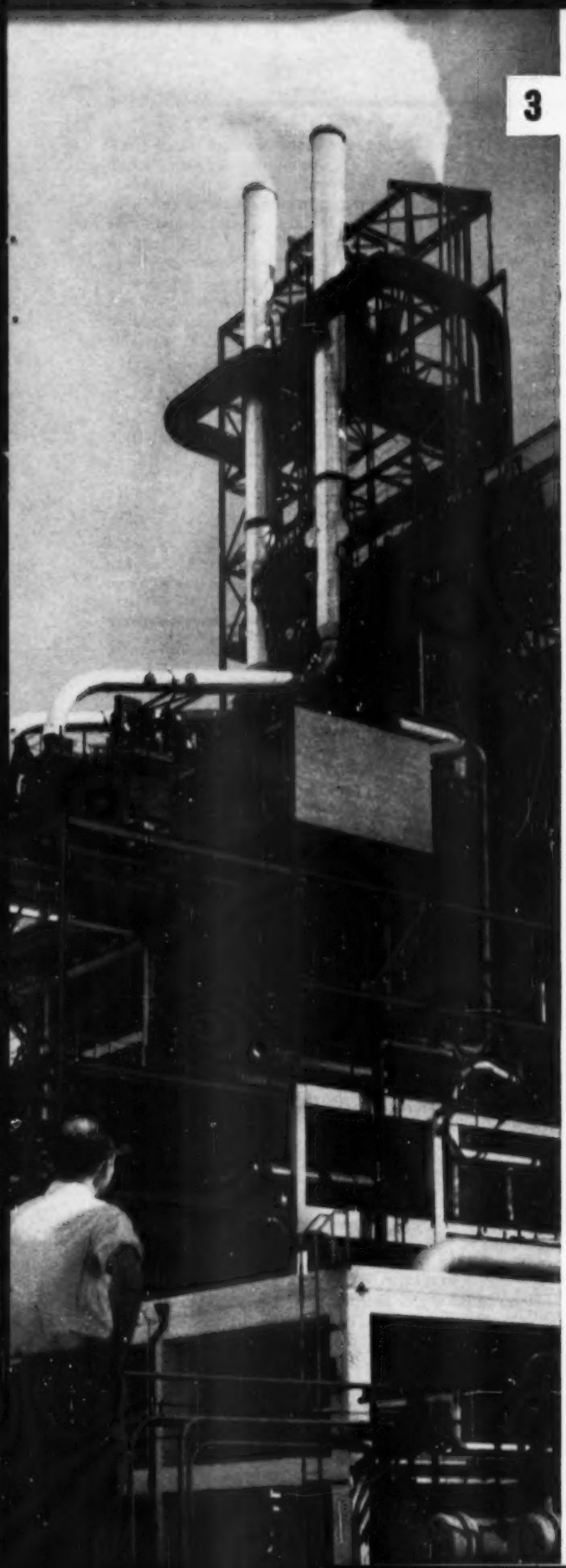

3

Stainless Steel wins three more battles with corrosion

1 High temperature sulfur corrosion from sour crude destroyed every metal tower in this plant. As the failures occurred, all towers were replaced with Stainless Steel lined equipment. Not one lining has failed since, and some of them have been in service continuously for eight years.

2 Two vacuum evaporators at this plant remove gas oils and asphalt from reduced crude at operating temperatures of 740° F. The evaporators were unlined at first, and inspection showed that they were failing rapidly from high temperature sulfur corrosion, coupled with severe erosion caused by the crude which entered the evaporators under pressure. The evaporators were promptly lined with Stainless Steel sheets, and, in five years of service, the sheets showed practically no wear. Plant engineers say they will be good for five to ten more years.

3 When they switched from sweet crude to sour crude in this "cat" cracker, the lower section of the fractionating tower corroded and had to be shut down for major repairs. The tower was repaired by installing Stainless Steel in all corroded areas. After three years of operation, the Stainless Steel was still in excellent condition.

When you consider all the materials that go into a refinery or petrochemical plant, very few will show such dramatic results as Stainless Steel. No other metal has such a desirable combination of corrosion resistance, surface density and smoothness, strength (even at high temperatures) and ease of fabrication. Build and repair with Stainless Steel. And for service-tested quality, specify USS Stainless Steel.

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may be used to minus 50 F for average service such as vessels, pipe, valves and etc., but for severe shock even these should be limited to a higher temperature. For service temperatures below minus 50 F nickel steels or non-ferrous materials should be used. The addition of nickel to the ferrous base will reduce the transition temperature; depending upon the amount of nickel. In Table 1 the division of minus 50 F to minus 150 F is for 3 to 3½ percent nickel steels. Depending upon the degree of control during manufacture, this steel will show Charpy Keyhole-Notch impact values as high as 20 to 25 ft-lb at minus 265 F. An increase to 5 percent nickel for this same steel will show about the same results at minus 290 F.

Division of minus 150 F to minus 320 F usually results in the selection of the non-ferrous or austenitic stainless steels, such as type 304; however, the low carbon 8½ percent nickel steels, heat treated, will give 15 ft-lb Charpy Keyhole-Notch tests at minus 320 F.

Cost, relative to plain carbon steel, is approximately as shown in Table 2. It must be remembered that in the purchase of the alloy or special steel, quantity of the order greatly affected price, and the table, therefore, n.. or may not be in error depending upon the quantity considered.

Piping

Design of piping for sub-zero service does not differ greatly from that at elevated temperatures. Calculations for flexibility are made in the same manner, however, one must remember that movements are contractions and not expansions. Therefore, on the examination of the piping for flexibility must be more thorough for sub-zero temperatures than for elevated temperatures.

Here is a list of some of the many things to examine critically in any piping system:

1. Direction of movements.
2. Method of supporting.
3. Flange bolting.
4. Gasketing material.
5. Branch connections.
6. Temperature gradient.
7. Dis-similar materials.
8. Tri-axial stresses.
9. Re-entrant welds.
10. Valves:
    (a) Extended bonnet.
    (b) Packing.
    (c) Pressure relief for entrapped fluid.

Direction of movement of the piping as stated above is critical and must be examined closely. These contractions will also effect the method of supporting and anchoring the piping. The supports or hangers should be placed such that there will be a minimum of heat gain by the fluid in the pipe, this usually means hard maple wood blocks between the pipe support shoe and the steel or concrete support.

For pipe hangers, the pipe attachments should extend past the insulation a sufficient distance such that ice formation will not effect the operation of the hanger. Maintenance of the insulation seal around a piercing support or hanger is a rather difficult job to perform, as the formation of ice on the piercing member tends to break the seal. This problem can be lessened somewhat by insulating the piercing member for a distance from the pipe insulation of about twice the pipe insulation thickness.

The flange bolting will not be too great a problem so long as the contraction of the bolting and flange is similar. If possible, the bolting should be of the same or similar material as that of the flanges. Gasket material can vary quite widely, depending upon the service temperature and upon the fluid flowing.

Gaskets

Gaskets may be compressed asbestos, metal, metal jacketed or spiral wound retained. The compressed or sheet asbestos gaskets tend to become brittle at low temperatures and because of this, the writer does not use them for service temperatures below minus 20 F. Metal gaskets, and spiral wound gaskets may be used for temperatures to minus 320 F depending upon the materials. Aluminum, copper or austenitic stainless steel gaskets are all serviceable to minus 320 F. Plastic gaskets of the fluorocarbons, such as Teflon or Kel-F have been recommended for use at temperatures as low as minus 260 F. However, the writer has seen no data to show that these materials do not become brittle at this low temperature.

On piping, there is a tendency to change materials (on small branch connections) to main headers; this should be examined closely for corrosion due to dissimilar metals. This is true also for gasketing and bolting materials.

Welding

Welding of ferrous materials for sub-zero service is one in which the notched-bar behavior is complex due to such factors as:

- Dissolved gases
- Variations in base metal and weld metal,
- Heat affected zone,
- Re-entrant welds.

a. Dissolved gases may be minimized by using low hydrogen, coated electrodes or submerged arc welding.

Milo Palmer *received his BS in Mechanical Engineering at the University of Illinois and since has been engaged in the various phases of engineering as designer, project engineer, process control engineer, assistant to pipeline superintendent, refinery superintendent and other related work for the past 33 years with such companies as the Huasteca Petroleum Company, Tampico, Mexico; Lago Oil and Transportation Company, Aruba, D.W.I.; Shell Oil Company, Wood River, Illinois; Standard Oil Company, Sugar Creek, Missouri; and is now employed by the J. F. Pritchard & Company, Kansas City, Missouri, as chief design engineer.*

b. Use of electrodes of a material that is not compatible with the base metal may set up stresses due to the difference in expansion of the two materials, especially on thick walled materials.
c. Welding of ferritic base materials with austenitic electrodes may result in a brittle structure of the fusion zone because of dilution of the austenite weld metal. Some relief from this condition may be found by using type 310 electrodes.
d. Under-cutting and sharp edges are to be avoided for all low temperature service.
e. Anneal, where possible, for grain refinement.

Pressure Vessels

The ASME Code, Section VIII, Unfired Pressure Vessels, covers the design and construction for pressure vessels for temperature down to minus 20 F and more specifically, by paragraph UCS-65, 66, 67 and UHA-51 for temperatures below minus 20 F.

It will be noted that paragraph UCS-66-d lists certain exemptions to the requirements for impact tests, of which one is that no impact tests are required on *any* material for use at temperatures of minus 20 F and above, or for use

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below that temperature when due to a lower seasonal atmospheric temperature." The above statement is, in the opinion of the author, too broad a statement. For severe shock loadings even at room temperatures, the rimmed steels show very erratic Charpy impact tests and obviously should not be used at sub-zero service temperature.

Part UNF-65 exempts non-ferrous materials from impact tests down to minus 325 F.

Part UHA-107 cautions against the use of dissimilar weld metals when welding ferritic type stainless steels with austenitic type electrodes.

It would be well to exercise caution in stamping material for use in severe shock service at very low sub-zero temperature service because of the localized stress pattern that would be induced in the stamped material.

Valves

Block valves should have extended bonnets for service in which the fluid temperature is approximately minus 75 F and lower. Valve stem packing for the extended bonnet valves is not too much a problem due to the packing gland being outside the insulation. Generally, the under or pressure side of the gland is blanketed with vapor at a temperature higher than the temperature of the fluid in the line.

Safety

Safety protection must be provided on those lines handling highly volatile fluids such as methane, ethane, oxygen, hydrogen, etc., to provide for the vaporization of the fluid due to heat leak on a blocked-in line. The capacity of valve required may be readily calculated from the heat leak through the insulation. Trapped pockets of the cold fluid, such as in the bonnet of gate valves, plug valves, etc., must be provided with some means of relief against a build-up in pressure which may rupture the container if allowed to rise too high.

The classification of materials as to the minimum service temperature in which they should be used depends upon whether the material will be subjected to shock loading or upon a steady static load. If the load is a steady static load, it is obvious that plain carbon steel would withstand extremely low temperatures. This condition, however, rarely exists in process plants. In piping and equipment it is normal to obtain various degrees of shock; even the steady flow of fluid in a pipe will produce vibration which depending upon its velocity will vary from slight to severe vibrations. It is, therefore, important to select materials for sub-zero services which will withstand the shock expected at the service temperature.

Some of the non-ferrous materials used for sub-zero temperatures will not withstand very much heat and in case of fire may rupture rather quickly. This safety consideration may result in using the ferrous steels.

In the construction of equipment, it is quite common to use different materials to conserve on the more expensive materials of the piece of equipment. The expansion or contraction of these differing materials should be examined closely to make sure that the equipment will not bind rotating parts or warp the piece of equipment to such extent as to make it unserviceable or unsafe.

Of the many methods for measuring the low temperature embrittlement of ferrous materials, the Charpy Kayhole-Notch method is probably the best known as it is primarily applicable to the classes of steels of low hardness and low notched bar impact resistance such as hot rolled or normalized carbon and low alloy steels, and permits discrimination between the more and less brittle steels of the above types at room temperatures and below.

Generally for sub-zero service temperatures a minimum value of 15 ft-lb Charpy Keyhole-Notch specimen tests are specified for the material at the operating temperature. For some conditions of shock loading it would be desirable to increase the minimum energy from 15 ft-lb to 20 ft-lb or more depending upon the severity of the shock. * * *

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Cooperative Research and Development Service

A research and development service for companies seeking to develop new commercial processes is now offered by The M. W Kellogg Company, New York, a subsidiary of Pullman Inc., on a cooperative contract basis. Its unique objective is to provide reliable data that engineers need to design full-scale, commercial plants, and to obtain research results with *speed* and at *low cost*.

To facilitate cooperative research projects with industry, Dr. Raymond E. Vener, manager, Industrial Research and Development, has been placed in charge of preliminary discussion and liaison with clients.

Dr. Alex G. Oblad, Kellogg vice president in charge of Research and Development, formally introduced the service stating that compensation will be based on an evaluation of the commercial applicability of a process, rather than on time spent or the service performed.

Dr. Oblad cited successful cooperative research and engineering development projects Kellogg has handled in the past for industries including petroleum refining, chemical, iron ore and copper refining. He pointed out that the company now offers industry a R&D team oriented toward process rather than product development, and techniques, such as cross-fertilization of disciplines, developed to make research more efficient.

Kellogg cooperative research streamlines technological advancement in many fundamental ways:

- Increases possibilities of major technical breakthroughs by increasing brainpower forces. Projects can be undertaken which no one organization could handle alone.
- Lessens time required to reach conclusions on the technical and economic feasibilities of new projects.
- Gives investors fresh insights into long-range projects which may have slowed down.
- Applies experience from many fields and industries to each investor's particular situation.

While Kellogg is knowledgeable of the broad and specific technological aspects of production processing, the Company itself does not operate process plants. Benefits to the investor are the proving out of his process possibilities, greater objectivity in the development of his research efforts, and a fresh insight into his fundamental technical means of producing products.

Research groups of manufacturers often find a substantial portion of their research hours drained in handling the immediate necessities of constantly increasing product quality or performance. Larger, more fundamental ideas which could lead to greater overall efficiency are often delayed or set aside. Here cooperative research specialists can step in to concentrate on pushing the project forward. Missing technical links which may have delayed or complicated progress may be applied to project development. When the cooperative project is complete, it will have taken less time and fewer research dollars.

Refinery and Petrochemical plant applications of . . .

Metals Controlled by Service Stresses

The Refining and Petrochemical Industry has little or no use for material which does not have attractive properties on a long-term basis

Eric H. Bucknall, *Professor of Mechanical Engineering, University of Texas, Austin, Texas*

THE FIRST PETROLEUM REFINERY built in the U. S., which went into action in 1860, went a long way toward fixing the pattern of such plants as comprising assemblies of iron stills of varied sizes and shapes. Possibilities that improved products could be obtained by chemical treatment, alternative to or supplementing distillation, were envisaged at the start of the industry, but nothing along these lines was applied for many years, in fact until after many other developments such as thermal cracking, which came in with the demand for gasoline about 1900, and continuous distillation (1912). Vacuum fractionation brought in the first use of refrigeration in the industry, for production of low-temperature lubricating oil, a feature which later spread to solvent dewaxing. By the 1920's the industry had taken on the character of a highly complex chemical engineering activity. Its units operated over wide ranges of temperature and pressure, but had in common two features derived from the 1860 plant: They were essentially assemblages of static vessels and tubes (though naturally being served by mechanical pumps and compressors) and they all corroded severely. *Plant designers were caused to take a very active attitude toward corrosion, but developed a passive attitude toward stress.*

In the years that followed, stainless steels and other corrosion-resisting materials came into wide refinery use and the stage was set for the great expansion of the industry and its development of specialized products, dependent upon such processes as desulfurization, alkylation and catalytic cracking and reforming, all aimed at improving quality and yield of the fractions most in demand. Alkylation treatments are mostly relatively moderate temperature and pressure processes, but catalytic cracking and reforming processes often involve high temperatures and pressures.

An examination of data on the pressure and temperature conditions of main plant items concerned in principal refinery processes shows that extreme temperature and pressure appear to be 1150 F and something more than 8000 psig. While the most severe temperature and pressure conditions do not occur in association, temperatures up to 1100 F are used with pressures such as 1000 psig, and the highest reported pressures are met in processes operating at or near 1000 F.

Such temperature and pressure conditions would be regarded as severe in any branch of industry, even where comparatively short material life could be tolerated and from which corrosive fluids and reactive atmospheres were excluded, points which cannot be claimed for the petroleum refining industry, where plants are expected to serve eight years or more and the annual corrosion bill is in excess of $500,000,000. In refineries, metals and alloys should be selected to adequately resist, at all stages of service, the stresses which arise from plant pressure and other sources . . . a point of view which is perhaps too often subordinated to corrosion resistance as the main basis of refinery metal selection. This leads naturally to the question of what newly developed materials or products of new metallurgical processes may be of interest to the refinery plant designer.

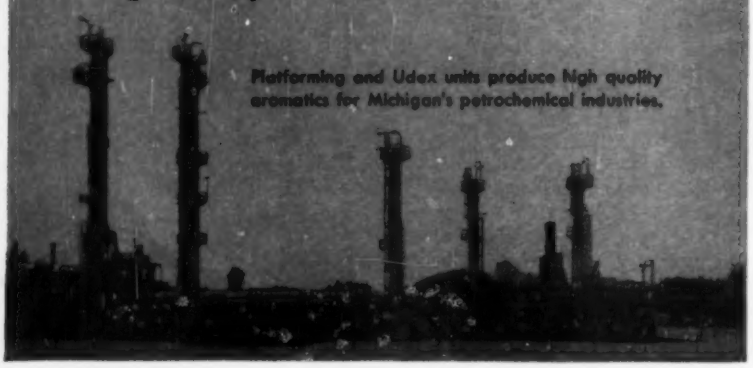
The refining and petrochemical industry has little or no use for materials which do not have attractive properties on a long-term basis, which throws out most of the newer high-temperature materials. Some have striking high-temperature properties, such as ability to carry a stress of 25,000 psi for 1000 hours at 1800 F, but do not look attractive when viewed against an eight year plus life expectancy . . . and the extraordinary capacity which refinery service has for modifying materials during service in composition and structure to the disadvantage of their mechanical properties and, especially, of their combined properties toward stress and corrosion. It is certainly fair to say that the industry places large demands, in all senses of the phrase, on the metallurgical industries and their products.

The intelligent use of metals comes to a considerable extent from the degree to which the industry pools its resources of knowledge of materials.

One cooperative research program was the extensive investigation sponsored at Battelle Memorial Institute in the early 1950's on graphite formation in plate steels of welding quality. The investigation was initially taken up because failures had occurred at Esso refineries in large pressure vessels operated at the temperatures used in catalytic cracking. Carbon steel plates from these vessels had shown some graphitization, especially in the vicinity of welds. Graphitization in low-carbon steels had not previously been encountered in industry and the occurrence was disturbing, so much so that studies were pursued even after analysis of the service failures had shown their cause to lie elsewhere, in thermal stressing caused by differential expansion of the carbon steel and internal 18-8 linings. Graphite formation was shown to be quite common in refineries. However, no case of failure due to this cause was traced, though one mild steel plate received from service seemed to have been near failure as its strength had

Nightview of UOP Fluid Catalytic Cracking (left) and "HF" Alkylation units at Leonard's Alma (Mich.) refinery.

UOP Fluid Cat Cracker boosts production of gasoline and quality distillates



Platforming and Udex units produce high quality aromatics for Michigan's petrochemical industries.

Leonard upgrades blending stocks with new UOP Fluid Catalytic Cracking and "HF" Alkylation units

by Reid Brazell
President
Leonard Refineries, Inc.
Alma, Michigan

The question has been asked of me frequently: What has motivated Leonard's growth as one of Michigan's most successful petroleum operations? It has resulted, mainly, from the challenge of the times. Each phase of our development has been chronologically prologued by conditions which have made advancement imperative.

Reid Brazell

Early Improvement Increases Gasoline Yield 130%

Back in the mid-thirties, our chief problem as a newly formed company was to improve octane rating and consumer acceptance of Michigan refined gasoline, known then as the "bargain" gasoline. Low in price, it was also low in grade. Our first step was the installation of a then brand-new refining development, the UOP two-coil selective Thermal Cracking Unit—which enabled us to produce a more competive product and increase our gasoline yield from low-grade crude by 130%!

First "midget" UOP Polymerization unit provided 100-plus octane blending stock

The quality picture further improved immediately thereafter with the addition of one of the world's first "midget" Catalytic

Polymerization units. It went on stream at our Alma refinery and provided 40 BPSD of 100-plus octane blending stock and permitted Leonard to market an 80-octane gasoline.

Post-War Opportunities Foster New Facilities

The end of the war triggered another surge of growth by Leonard. First, a small catalytic cracking unit added another 3,000 BPSD of quality product to our output and this unit was later revamped to up capacity to 7,000 BPSD. An LPG plant was completed, a vacuum unit went on stream, treatment plants were completed and 648,000 barrels of tankage was erected.

Expansion took another giant step in 1955 with Leonard's acquisition of Mid-West Refineries and Roosevelt Oil & Refining Corp. A 1,200 BPSD UOP Udex® unit, tied into Roosevelt's catalytic reformer, increased Leonard's petrochemical business, enabling us to produce quality benzene and toluene for sale as chemical intermediates and solvents.

Fluid Catalytic Cracking, and "HF" Alkylation Units Added

Another "changing condition" took place in 1958 when construction of natural gas pipelines into Michigan cut into the demand for residual fuel oils. With our gasoline and domestic heating oil sales up, but industrial fuel oil sales down, we added a 7,500 BPSD UOP Fluid Catalytic Cracking unit to reduce residual stock and produce more gasoline and quality distillates.

Simultaneously, a 1,100 BPSD "HF" Alkylation unit, designed and licensed by Universal, went on stream at our Alma refinery. Producing a 105-octane blending component, the unit made possible a super-premium fuel of more than 100-octane.

Today, Leonard's refineries total nearly 30,000 barrels per day of crude capacity. With a broad range of facilities encompassing UOP Catalytic Cracking, Vacuum Distillation, UOP Platforming®, Thermal Cracking, Udex extraction, "HF" Alkylation, Platreating* and Catalytic Polymerization, we stand ever watchful of "The Conditions of the Times" as a stimulus for future growth.

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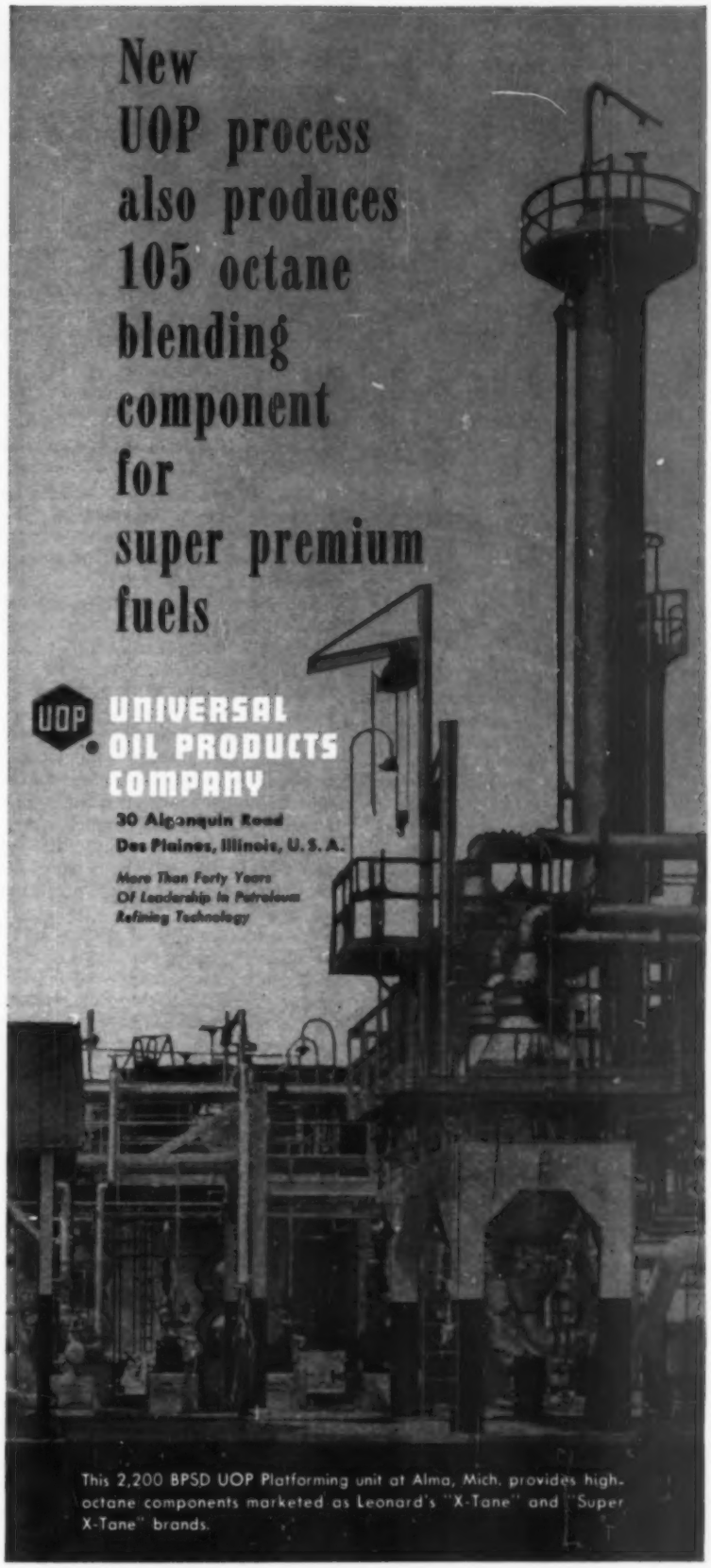

This 2,200 BPSD UOP Platforming unit at Alma, Mich. provides high-octane components marketed as Leonard's "X-Tane" and "Super X-Tane" brands.

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dropped from 70,000 to 35,000 psi and it showed no ductility in the tensile test.

Unlike the graphitization which takes place when white iron is heat-treated to form malleable iron, graphite formation in the susceptible low-carbon steels was confined to the temperature range 830 to 1400 F and proceeded fastest at 1150 to 1200 F. Heavy dosing with aluminum favored graphite formation and silicon is said to be an accelerator. Carbide stabilizers such as molybdenum in alloy steels oppose graphitization, and 1 percent chromium-molybdenum steels appeared immune. Such steels have, however, reduced weldability, so that trouble with repairs and alterations would have followed on any wholesale turn-over to steels of this type for vessels serving in the graphite formation range. Nor was it at all certain in 1955, when the results were published, that drastic measures were indicated. Esso Research saw the future development of catalytic cracking equipment as involving the use of internal insulation, permitting reactions at 900 to 1000 F to proceed in vessels with a wall temperature of 650 F.

The fields of application of unstabilized 18-8s with various carbon contents down to 0.03 percent and of the stabilized varieties have been discussed in the literature. For most applications, the main danger with these steels is that they develop inter-crystalline weakness and susceptibility to intergranular corrosion, as a result of chromium carbide precipitation locally impoverishing the steel in chromium. Possible sources of chromium carbide are: Lack of solution of carbides in high-temperature annealing, which is always given; precipitation during cooling after annealing; and separation in zones parallel to the line of welds, where temperatures of 925 to 1650 F have been reached and held for appreciable times during welding. Generally, use of the steels is at such a temperature that additional precipitation does not occur in service. For most applications, only the third source need be taken seriously and then only for higher carbon materials and thicker plates, where the time spent in the dangerous range during welding may be several minutes. Refinery service, in such items as catalytic crackers, affords very long times of exposure at the lower temperatures of the carbide formation range and so gives ample opportunity for any unstabilized steel with above 0.03 percent carbon to reject chromium carbide; and even for stabilized steels with above 0.05 percent carbon to reject carbides. For refineries, the steels may best be used in the special condition where pre-precipitation has occurred. *In which cases should an 18-8 steel with 0.03 percent or 0.05 percent carbon or a stabilized steel be chosen?*

Professor Bucknall *was born and educated in England, where he studied metallurgy at the University of Birmingham, receiving BS and MS degrees. His thesis was a research on copper alloys and he has been principally engaged in metallurgical research ever since. In 1929, he went to the National Physical Laboratory to work under Walter Rosenhain until he joined the Mond Nickel Company (Inco. in England) in 1939, and became deputy to the superintendent of the Research and Development Laboratories. In 1951, he represented the U. K. Government in Washington at the International Materials Conference, which rationed raw materials during the Korean War. He left Mond in 1953 to become director of the National Metallurgical Laboratory of India, a post he doubled with that of government director of inspection for metals. He joined the University of Texas in 1956 as professor of mechanical engineering with special metallurgical responsibilities.*

In the engineering field in general, metals and alloys find applications not only in a great variety of service but also for many reasons. The two most common grounds for selecting a particular material are availability and ease of production of the required form. It is often advantageous for the material to be capable of achieving two distinct solid constitutions, in the one of which it is easily fabricated and in the other it has desired service properties; steels and heat-treatable nonferrous alloys owe much of their application to this feature. Frequently, the properties called for are properties in combination, such as good high-temperature strength in an alloy resistant to scaling. When service produces complex interactions between the factors concerned in such a combination, phenomena such as stress-corrosion and corrosion-fatigue arise, material selection clearly becomes a matter for the specialist. The non-specialist is in any case commonly liable to go astray by crediting property levels to details of composition, when they are common to materials with a given structure.

Special problems arise when we use different materials side by side, as we often must, for example where the parts must be capable of smooth relative movement. The problems include galvanic corrosion risks, but are not confined to corrosion. Specially serious are cases where the juxtaposition of dissimilar materials sets up differential thermal expansion and hence thermal stresses; in use steels clad with aluminum, nickel or stainless steel are all troublesome, because of a 50 to 60 percent difference in expansivity.

In the absence of corrosion, metals fail because of excessive deformation under stress, but several mechanisms of deformation occur, some of which are much less homogeneous than others and therefore lead to fracture at smaller degrees of deformation. It is important to remember that metals never deform completely uniformly. Even under the simplest conditions localized stress and strain conditions arise and promote failure.

The more serious potential sources of fracture are discussed below:

1. Low-temperature brittleness.

In view of the appearance in this issue of two articles dealing with subzero temperature service, only limited attention will be given to this important source of industrial failures, especially as regards refrigerated plant and equipment located where the ambient temperature is low. It is a limited phenomenon in two senses; the susceptible materials form a limited class, structure-wise; and the embrittlement persists only so long as the temperature is held low. Face-centered cubic materials are not susceptible, though when impure and having embrittling precipitation around the grains they may become subject to the intercrystalline cracking variety of the phenomenon; this occurs in bismuth-containing gold, impure thorium and possibly in sensitized austenitic steels. Usually, the presence of a proportion of a face-centered constituent, as in 10 percent nickel steel, is enough to ensure freedom from the effect at all practical service temperatures.

2. Constitutional embrittlement.

Materials which enter service, at a temperature at which diffusion proceeds at an appreciable rate, in an unstable condition naturally suffer constitutional changes in the direction of attainment of equilibrium. Graphitization of low-carbon steels, sigma-phase (FeCr) formation in alloy steels and overaging in aluminum alloys are all examples which result in brittleness,

not usually sufficient to cause failure in service, but which is noticed when the plant is next stripped down. Changes of this sort are almost invariably accelerated by stress, or perhaps more correctly by non-elastic strain; the best-known case is strain-age embrittlement in unstabilized high-nitrogen mild-steel.

3. Creep and stress relaxation – high temperatures.

Creep is flow of solid metals under steady stress and temperature, it occurs in all metals which serve at temperatures at which they are able to recrystallize after cold working. The phenomenon is more serious industrially at temperatures just above the threshold of the recrystallization range than at higher temperatures, for two reasons: Materials do not have enough strength high in the recrystallization range to be industrially applicable, and it is at the low temperatures in the range that creep leads to characteristic, low-elongation fractures. Creep cracking is intercrystalline, starts at the surface of the piece and runs roughly normal to the stress axis. In some fields of service, creep rates are important as such, but this is not usually the case in refinery service, where the danger is of cracking. In service spread over a year or more, few materials prove capable of experiencing an elongation of even one percent. The temperatures of most items in a process unit are within the creep range of the materials used: Lead creeps at room temperature, aluminum alloys creep freely at 250 F, most copper alloys are subject to creep at 400 F and carbon steels at 550 F, while austenitic steels begin to creep at about 750 F. For creep resistance, an alloy should be cast rather than wrought, have coarse grains and a stable microstructure, preferably comprising a saturated solid solution (at the working temperature) plus a refractory precipitate such as an alloy carbide.

4. Fatigue.

Until aircraft wing flutter and the failure of the pressurized cabins of the first Comet jet-liners forced attention on the fatigue of structural members, fatigue was commonly thought of as being confined to parts of moving machinery and to ordinary temperatures. The popular concept of a typical fatigue failure and of the role of notches in fatigue comes from room temperature, multi-million cycle failures of steel. The field of action of fatigue ranges, however, over a wide variety of materials and temperatures and the number of cycles to failure may be few or many. While the fatigue nucleus in a "typical" fatigue failure is smooth and has shell markings, high temperature fatigue may result in rough, intercrystalline fractures; moreover, instead of appearing as a relatively "short" or brittle type of failure, fatigue of a metal in the creep range is comparatively ductile.

An important point, first observed in 1912 but neglected, which has recently been emphasized by A. C. Low is that in short-endurance fatigue, instead of there being an inverse correlation between stress range and number of cycles to failure, the correlation is between strain per cycle and number of cycles. This implies that for cases where the effective stress arises only occasionally, as in plant which is severely stressed only at start-up and shut-down, there is little merit in choosing a strong material. Even where this point does not arise, it is now clear that possession of high strength does not ensure high fatigue limit, since the ratio between these depends on structural factors, e.g. in steels at room temperature, austenite has one endurance ratio, ferrite another, and so on.

Fatigue seizes on the weak places in a structure and plays on them in a way which does not occur in static stressing, except under creep conditions.

Induced or transmitted vibrations are common sources of fatigue, and such causes are in general action in refineries and similar plants where fluids are being pumped or boiling occurs. Fatigue stresses may also be thermal in origin.

The cases discussed above are those which are most prone to cause metal failure in the absence of corrosion. It is not the purpose to discuss corrosion failure as such, but it should be pointed out that dry-corrosion, or scaling, can be a very serious matter in some cases. Much of the service of metals in refineries is under reducing conditions, and a major risk is hydrogen pick-up and ensuing steel embrittlement. In pipe-stills and other furnaces conditions are predominantly oxidizing and scaling is the main issue. Most metals usually protect themselves against excessive scaling by forming protective oxide layers, and some metals are able to bring oxidation to a stop while the oxide layer is thin; these include chromium and aluminum. In other metals, however, such as zirconium, what appeared to be a protective scale breaks down after long exposure and oxidation reverts to its initial rate. The industry had a scare during World War II when metals which usually are adequately self-protecting proved to scale away rapidly and continuously in the products of combustion of certain crudes and residual fuels, containing vanadium pentoxide, which evidently functions as an exchange-agent for oxygen. The same type of scaling occurs in certain alloys rich in the refractory metals, such as tungsten, molybdenum or vanadium. The scaling of nickel-chromium alloys, which is normally fully protective, takes a curious turn when oxidizing and carburizing conditions co-exist or alternate. The chromium in the neighborhood of grain boundaries is carburized and then the chromium carbide oxidizes to green chrome oxide, thus removing the main element responsible for the high temperature mechanical properties. The effect is called "green rot."

It is opposed by adding iron and silicon to the alloys. Silicon also opposes sulfur attack on nickel alloys.

When the cases of mechanical failure discussed above find themselves super-imposed on corrosive conditions, producing either wet or dry corrosion, a great number of specialized combinations result. For example, to the cases of embrittlement discussed above must be added cases where the stress system is able to produce spectacular results by acting on materials altered in composition by reaction with the environment.

The reaction of steam with steels increases markedly with respect to rate when the steel creeps during exposure.

Bubble-caps often suffer stress-corrosion at the liquid line. Bastien and Amiot have drawn attention to the way steels immersed in dilute aqueous hydrogen sulfide pick up hydrogen and are embrittled so that mechanical failures occur. The effect is most severe in martensitic steels, but well-tempered nickel-chromium-steels are practically immune.

It is impossible to deal here, even in the most summary way, with all these possible combinations of stress and corrosion. Instead, attention will be given to what is perhaps the most important single field from the industry standpoint . . . high-temperature corrosion-fatigue. As already pointed out, fatigue is commonly thought of as predominantly a room temperature phenomenon; similarly corrosion-fatigue seems to promote in many minds a picture of a metal undergoing a Wöhler Test while a wick laid across it conducts a thin stream of a cold corrodant into contact with the stressed area. It is, however, the case that at any temperature at which fatigue occurs corrosion-fatigue can also occur, and any form of corrosion which tends to form pits or otherwise isolate weak places in the specimen must promote fatigue, and give results equally, or almost equally poor, as those given in plain

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fatigue by bars with severe mechanical notches in their surface. The corrodant is usually an electrolyte, but this is by no means essential. In association with a former colleague, plain and corrosion fatigue failure were studied in the materials used for aero-engine exhaust valves and showed that the products of breakdown of lead compounds in anti-knock gasoline additives caused a great reduction of fatigue strength and a change in the mode of cracking.

There is no lack of liquids which will act as corrodants in corrosion-fatigue in the refinery; such substances do not need to be corrodants in the absence of stress to have very serious effects in promoting this insidious type of failure. The stress for corrosion-fatigue in the refinery, like that for plain-fatigue, as discussed above, is mainly thermal in origin, coming from unequal heating, differences in thermal expansivity, and sudden local cooling of heated surfaces by liquids contacting them (such liquids are commonly the corrosive element in the failure).

An important practical paper on fatigue by Goodger discussed corrosion fatigue cracking of heated surfaces subject to wetting, although the design engineer might have been more impressed by it, if it had had less emphasis on steam plants. In such service, cyclic stresses arise from the repeated local contraction suffered by the hot surface, while the liquid may cause corrosion. Stress levels may be so high that failure occurs in comparatively few cycles, but these may occur with such low frequency (only on bringing the plant up and down), that life appears long. The tensile stressing may be as high as the yield stress in steels and thus would cause early cracking in the absence of corrosion; corrosion, of course, would accelerate cracking. With water as the corrodant, cracking is trans-crystalline . . . unless the water is alkaline and the stressing low, then cracking would occur between crystals.

Setting this exceptional case on one side, Goodger says: "All the cracks in this form of failure are transcrystalline, filled with magnetic oxide which is fractured to the base, and all cracks are of the typical corrosion fatigue type. . . . It is clear that such cracks are produced as the result of repetitions of stress, probably of the yield order, and the corrosive effect is probably that of the steam/iron reaction. Whether hydrogen has any effect is difficult to say, but hydrogen will be evolved at much lower temperatures than those at which scaling becomes noticeable, namely at about 1060 F. There is evidently a connection between the strain wedges as shown by Lüders lines and the spacing of the cracks. . . . The shape and direction of the cracks appear to depend upon the shape of the stressed area and the flexibility of the part, stress which is largely uni-directional giving linear cracking which may be longitudinal or circumferential, the cracking being at right angles to the principal stress. If the stressed area is reasonably regular in shape and the part rigid, the general form of cracking is a crazy pattern." There is commonly a tendency for affected parts to bulge outward because of the high compressive stress, when uniform temperature is reached, acting in conjunction with the force exerted in the wedge-shaped cracks by the products of reaction.

Goodger points out that a corrosion fatigue problem of this sort may exist, and cracking be accelerated by corrosion, even when no liquid is present, i.e. when the atmosphere or a furnace atmosphere acts as the corrodant. In such cases temperature is highly significant. He found that in a 0.5 percent molybdenum steel a marked drop in resistance to corrosion fatigue occurred at 750 F, while a 1 percent chromium-molybdenum steel had the sharp decrease postponed to 930 F. He gives examples of cracking in superheater tubes, boiler tubes, a solid forged boiler drum, de-superheater bodies, economizer piping, steam receivers, soot blower piping and turbine loop piping, and points out that the effect may be expected wherever a liquid strikes a hot plate, and especially where the temperature difference is large. In modern superheated steam plants, differences in metal and water temperature reach 500 F. The alternation which occurs in such a case from nuclear to film boiling may set up a short-cycle variant of the process, leading to early failure. Goodger considers possible remedies. The real remedy is in prevention, by limiting thermal cycles. Measures such as peening or plating have little effect, since any favorable stress distribution is soon lost and because the presence of dissimilar metals introduces additional expansion effects. Parts which are found to be affected but not severely cracked may often be reclaimed by grinding out the cracks, but there are obvious limitations to this procedure.

Goodger's views were supported by a paper by Cottell, which, while again dealing mainly with steam service conditions, had much to say which is directly applicable to refinery failures. He points out that it is not always possible to eliminate the corrosive fac-

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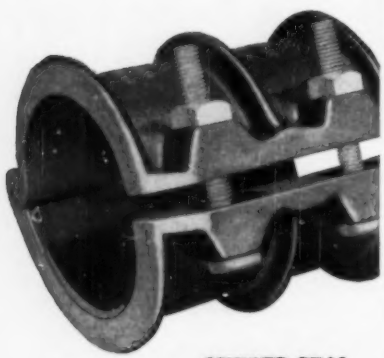

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tor, or nullify it by selection of materials consisting throughout of, or faced with, corrosion-resistant alloys. In such cases, materials of high notch-fatigue resistance should be chosen and the operator should exercise continued care to prevent neglect or abuse in service and ill-conceived repairs.

Metals such as titanium, zirconium, tantalum and columbium have been much discussed in recent times. They are all relatively expensive; from most consumers' standpoint, only titanium is at all reasonably priced. All have well-established fields of application in meeting specific corrosion problems, for example both titanium and zirconium give better service in brines than any other metals. They have been used to a limited extent as stirrers in chemical plants, and zirconium (of a special purity) has formed the basis of alloys (with tin) which show great promise as uranium-sheathing materials in nuclear energy plants. Titanium has proved disappointing in two respects: its virtual impossibility to use as a cladding on steel, because of welding difficulties; and because of its creep properties. It has been found that there is only a limited temperature range in which the specific creep resistance (creep resistance divided by density) of titanium is attractive. This range, 500 to 650 F is that in which aluminum alloys have failed and steels have not yet come into the picture; it so happens that this range is of great interest as the temperature range most likely to exist in the skin of high speed stratospheric aircraft and space ships, and is also the range in which some high-duty compressors operate. Zirconium has high temperature properties which are best described as 200 F better than titanium. Tantalum and columbium are refractory metals, but suffer from their affinity for oxygen and carbon which limits their serviceability. Beryllium and chromium are two metals much spoken of as having great promise in the high temperature field, alone or as alloys. Both metals as at present produced are brittle; the brittleness of beryllium can be got around by using powder metallurgy, but the products are limited, as well as very expensive; deoxidation of ingots seems impossible. Brittleness in pure chromium extends to above 500 F and no alloying elements have been found which lower the brittle transition.

When we turn from new metals to newly developed alloys of well-established metals the position is perhaps less unattractive. Such alloys are mostly the precipitation-hardened varieties of established types which suffered from inadequate strength or wear resistance. There are, for example, age-hardened

varieties of the principal nickel alloys, including cast and wrought Monel, Inconel and 80-20 nickel-chromium, and the special low-expansion nickel-iron alloys, as well as the constant Young's modulus alloys. The precipitation hardening (PH) stainless steels are among the important newcomers to this field. Such alloys have very definite advantages in strengthening material to resist static failure, but may be a disappointment where fatigue occurs; this may be either because the fatigue is of the short-endurance type, discussed above, for which strong materials have little advantage, or because the failure mechanism causes over-aging in the weak place which it has picked out for heavy deformation.

As compared with the difficulties of making specific recommendations of new materials, it seems relatively easy to name several recent metallurgical process developments from which the petroleum refining industry should profit. These include:

1. **Continuous-casting of alloys, including steels**

. . . especially the higher alloy steels. Not only do processes in which the casting takes the form of a continuous or semi-continuous billet, or slab, lessen the work to be done in producing wrought material in highly elongated forms, but they make practical the working of certain highly alloyed materials with contents of hard, angular compound phases, when the same alloys cast as ingots almost defy working. This has proved to be the case both for steels, such as those with high refractory carbide contents and for aluminum alloys in which coarsely developed angular compounds give rolling trouble.

2. **Other foundry developments**

. . . as in precision casting, which permits small parts needed on repairs or alterations to plant to be produced on the spot in special alloys, with special wear resistance and/or high temperature properties, as for example cobalt-chromium-tunsten-carbon compositions. Such processes may be combined with consumable electrode melting, to provide means of making castings in molybdenum and other high-melting point metals.

3. **Development of improved grades of cast-iron**

. . . by control of solidification by additives which promote undercooling and cause the spheroidization of graphite. Magnesium, as metal or as nickel-magnesium or ferro-silicon-magnesium is the usual additive, but magnesium plus cerium is better for dealing with

base irons containing interfering elements.

4. **Oxygen-lancing and related methods**

. . . by which very low carbon stainless steels, including 0.03 percent carbon 18-8, can be made without use of low-carbon ferro-chrome, offer great promise to an industry, which is one of the main consumers of such steels and would use more if it could afford to make vessels completely from stainless steels instead of using lined carbon steel vessels. The low-carbon stainless steels take a better polish than the stabilized steels and have better resistance to some types of corrosion. It is to be expected that they will be increased in availability and slightly cheapened by the recent developments, but it is doubtful whether the economics of the all-stainless pressure vessel will become attractive.

5. **Availability as alternatives**

. . . to the traditional nickel-chromium steels of steels in which manganese substiutes for some or all of the nickel. These and other fairly recently introduced manganese alloys stem from the availability of electrolytic manganese metal and of very low-carbon ferro-manganese, which allow for the first time alloys to be made which are high in manganese and at the same time have their carbon kept very low. It is possible for example now to make welding quality steels with manganese contents above 1½ percent.

6. **Extension of the scope of extrusion**

. . . which has followed on the invention of the Séjournet process in which the billet to be extruded is wrapped in fiber glass, or otherwise glass-coated. The glass has two main effects, it restricts heat exchange to the surrounding cylinder, so that this gets no hotter during the extrusion of steel than it formerly did in extruding a copper-base alloy, and it lubricates the die. Extrusion is now regularly applied to steels and heat-resistant nickel alloys, not only to produce rods and standard extrusion sections, including tube blanks, but also as the main primary break-down process by which the structure of the cast material is converted into something which can readily be worked by other processes. Developments in cold extrusion, and in tensioned rolling may also serve to supply the refinery industry with the materials it requires, but the advance in hot extrusion is probably the greatest single advance in providing high alloy materials in extended forms which has so far arisen.

7. **Developments in powder metallurgy.**

The production of solid products in this way is an alternative to precision casting for on-the-spot replacements, but the main applications probably lie in: The S.A.P. type of high strength aluminum, which is effectively an aluminum-oxygen alloy, with the corrosion resistance of aluminum allied to the tensile strength of the strong alloys; production of porous plates and discs for use as filters of extremely corrosive solutions. It is possible for example to make filters by this means for strong caustic soda from nickel powder and retain metallic mechanical properties in combination with about 85 percent porosity.

8. **Progress in welding and weldable steels.**

Controlled-hydrogen and deep-penetration electrodes have eased the welding of heat-treatable low-alloy steels which formerly gave much trouble with hydrogen embrittlement in the weld zone, the one type operating by exclusion of hydrogen sources in welding and the other by large dilution of the weld metal with plate material. Important progress has been made in welding clad steels as a single unit. Several steels have been developed which combine high yield strength with the welding properties of mild steel; these are usually based on the securing of transformation characteristics which allow strong, undercooled ferrite-pearlite structures or upper-Bainite readily to develop, but do not permit lower-Bainite or martensite to form even at the highest cooling rates encountered in plate welding. A steel with ½ percent molybdenum plus boron is an outstanding example. As regards stress-relief after welding of heavy plate to form pressure vessels, the nuclear energy people have demonstrated that, if willing, even the largest vessels do not provide serious problems, you simply build an electric furnace on to them!

References

1. Hall, A. M., "Graphite Formation in Petroleum Refining Equipment," Proceedings, Fourth World Petroleum Congress, 1955, Section VII, pp. 213-223.
2. Lilljekvist, O., and Hansen, S., Proceedings, Fourth World Petroleum Congress, 1955, Section VII, pp. 171-178.
3. Low, A. C., "Short Endurance Fatigue," Proceedings, ASME-IME International Conf. Fatigue of Metals, 1956, pp. 206-211.
4. Holmberg, M. E., "Selection and Use of Precipitation Hardening Stainless Steels," ASME Paper No. 59-PET-17, 1959.
5. Bucknall, E H.., and Price, L. E., "Etude de l'attaque des Atmosphères controlées sur les resistors et autres parties des fours en alliages nickel-chrome," Revue de Metallurgie, 1948, XLV, pp. 129-138.
6. Bastien, P., and Amiot, P., "La Fragilité des Aciers due l'Hydrogéne. Proceedings, Fourth World Petroleum Congress, 1955, Section VII, pp. 151-169.
7. Bucknall, E. H., and Ball, F. A. "Récherches sur les soupapes d'échappement des moteurs d'aviation," Revue de Metallurgie, 1952, XLIX, pp. 249-261.
8. "Corrosion Fatigue Cracking Resu'ting from Wetting of Heated Metal Surfaces," Proceedings, International Conf. Fatigue of Metals, 1956, pp. 394-400.
9. Cottell, G. A., ibid, pp. 563-569. ★ ★ ★

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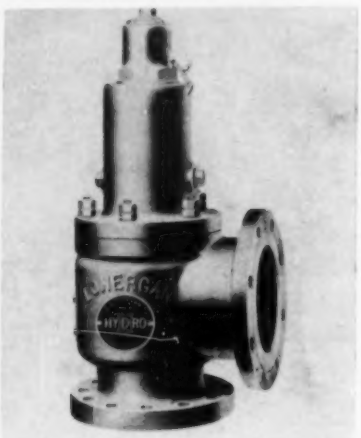

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Epoxy Repair Kits

Epoxy multi-use repair kits for making "on the spot" repairs in plant, mill and factory, have been released. Kit is two-component, fast setting, epoxy material that cures to hard, tough, tightly bonded patch, restoring damaged or broken piece to original condition. Years of usable life can be obtained from damaged equipment. Breakdown delays are shortened as immediate repairs can be made. Two types of repair kits are available. Carbo Fix S is general repair material with good chemical resistance for repairs to most all surfaces, including glass. Carbo Fix C has excellent chemical resistance and is recommended where chemical attack is of major consideration. Each kit contains jar of resin, jar of catalyst, fiberglass cloth, measuring spoons, stirring paddle and instruction booklet. *Carboline Co.*

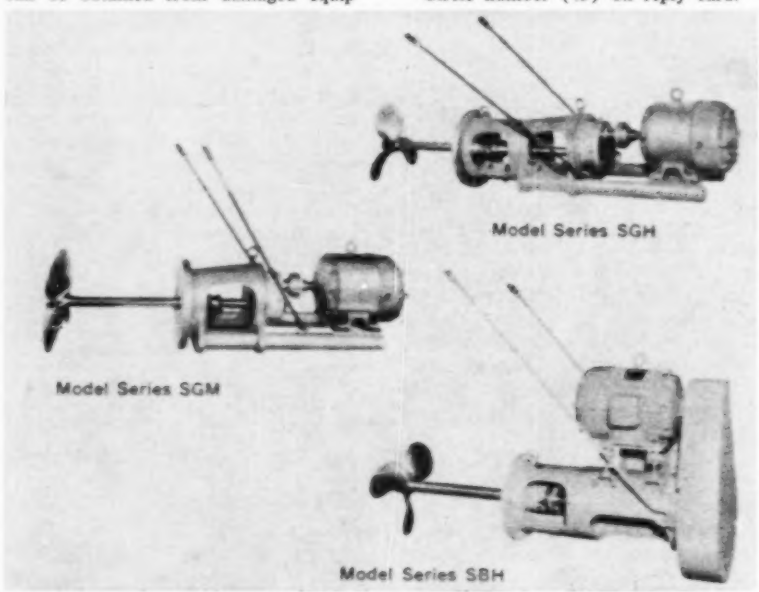
Circle number (44) on reply card.

Powered Drum Handlers

Powered high-lift models added to line of all purpose drum handlers employ telescoping mast which permits a low, close height for easy manuevering ability. Drum handler is designed to make it fast, easy, and safe for one man to handle, raise, lower, rotate, and dump loaded drums.

Model 796, which will pick up a drum from either a horizontal or vertical position, will elevate up to 800 lb to a height of 8 ft above the floor with the drum vertical or 8 ft-7 in. with the drum horizontal. In pouring position drum head extends a full 10 in. past the wheels, regardless of height. Available in a choice of three drives: Battery powered with built in charger, air motor, explosion proof A.C. electric, all of which provide lifting speeds of 16 ft per min. *Specialty Machinery Corporation.*

Circle number (45) on reply card.



Side Entering Agitators

Three styles meet every requirement: Model Series SBH provides 1-25 hp V-belt drive at 420 rpm through ample, ball bearing supported shaft. Stuffing box is integral with mounting flange; packings are in accord with modern design practice and can be replaced with tank full. Model Series SGM has gear drive, side entering agitators for standard duty. In-line designs are sized for 1-25 hp, 420 rpm output speed. Model Series SGH has heavy-duty in-line geared drive units for extremely severe service. Sizes from 1-30 hp have 420 rpm output speed, heavy-duty center ball bearing for additional support. *Chemineer, Inc.*

Circle number (46) on reply card.

Explosion-Resistant Lamp

Explosion-resistant safety lamp cuts price of this type of tool to a small fraction of former costs. Jetlite features ultra-high-intensity illumination, supplied by 65,000 candlepower aircraft landing light and provides relatively shadow-free spots of about 2500 ft-candles at 3 ft and 1500 ft-candles at 5 ft—with minimum lamp life of 100 hours. Small, lightweight Jetlite unit, including cord and transformer, is completely sealed in vulcanized neophrene rubber providing reliable performance in any weather condition in highly volatile situations. *Burton Manufacturing Company.*

Circle number (47) on reply card.

Linear Viscosimeter

Determining viscosity and flow characteristics of a wide variety of materials is now child's play with the fully recording, completely linear viscosimeter, according to the manufacturer. Available with 15 paddle designs, "Visco-Corder" measures viscosity of practically all fluids

and features stepless variable speed drive (0 to 200 rpm), disposable paddles and sample containers and interchangeable tension spring cartridges from 125 to 2000 cmgms. *C. W. Brabender Instruments, Inc.*

Circle number (48) on reply card.

Explosion-Proof Locomotives

Explosion-proof, diesel hydraulic locomotives to be offered on the American market feature regulation of exhaust gas temperature by water injection into exhaust pipe and thermostatically controlled shut-down valve that operates when exhaust temperature exceeds 320 F. Engines also have a valve that shuts down when engine speed is reduced below a pre-set minimum for protection if an explosive mixture is drawn into air intake. Electrical equipment on the locomotives is equally well guarded. Engines for these locomotives produce up to 500 hp in naturally aspirated or supercharged models with 6 and 12-in. line cylinders. *Henschel-Werke G.m.b.H.*

Circle number (49) on reply card.

Cast Header Bodies

Integrally cast from type CF-8 stainless alloy, these header bodies resist extremely corrosive conditions encountered in refining crude oil at high temperatures and pressures. Fittings are subjected to cold

kerosine pressure tests at 3000 psi to meet ASTM specifications. Integrally cast header body reportedly represents more satisfactory and more economical design than fabrication from wrought materials since welding is avoided and machining requirements reduced. Another advantage is good resistance to severe mechanical shock. *Alloy Casting Institute.*

Circle number (50) on reply card.

"MITE" 74

. . . with Integral 3-Way Valve is a precision instrument of extremely compact size for pressure limit protection. It automatically trips on decreasing instrument air signal either to vent or lock up downstream air, with no bleeding of signal air before or after trip. Trip point is adjust-

able from 1 to 100 psig. Repeatability ±0.25 psi. "MITE" 74 can be reset after signal pressure is restored to approximately 10 percent above trip setting. *George W. Dahl Company, Inc.*

Circle number (51) on reply card

Choosing an Antioxidant?

DALPAC® 4

SAVES

YOU

MORE

Refinery customers have found that, in comparison with other inhibitors, Dalpac 4 (Hercules 2,6-di-tert-butyl-p-cresol) saves up to three dollars on every thousand barrels of gasoline produced. Dalpac 4 inhibits gum formation, stabilizes gasoline color, and helps maintain engine cleanliness. Refiners have also found it to be excellent in turbine and transformer oils where it prevents deterioration, and does not affect electrical properties.

For additional information write:

Oxychemicals Division
Naval Stores Department
HERCULES POWDER COMPANY
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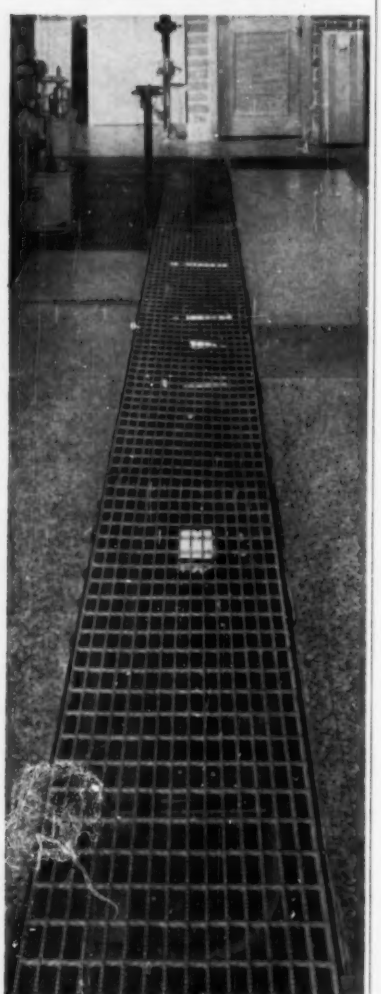

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New Literature

Heat Transfer Cement

. . . 40-page design reference has been compiled and arranged to aid the engineer in designing external heating and cooling systems. Divided into 4 sections, Section I of the bulletin gives useful engineering properties of Thermon, an inorganic heat transfer cement that is adaptable, efficient, economical and is streamlining the science of external heat application. Section II gives useful engineering data and calculations for design. Sections III and IV present estimating data and useful physical properties of liquids and solids. Thermon's low cost enables the designer to realize savings up to 90 percent of cost of equal jacketed equipment. *Thermon Manufacturing Company.*

Circle number (52) on reply card.

Annunciator Systems Catalog

Comprehensive information on Panalarm annunciator systems is contained in 52-page catalog organized for quick, easy reference. Text is abundantly illustrated with equipment photographs, charts and diagrams. Function of annunciators and their applications are included, and various types of annunciator equipment are described with mechanical and engineering data offered to aid in selecting proper equipment for any application. *Panellit, Inc.*

Circle number (53) on reply card.

Deaerating Heaters Bulletin

Revised and enlarged bulletin on spray type deaerating heaters discusses many aspects of the process and equipment, including principles of deaeration, deaerator operation, standard designs available, design features and accessory equipment. *Graver Water Conditioning Company.*

Circle number (54) on reply card.

Valves, Fittings Catalog

Complete dimensional data and type drawings for stainless steel taper seal valves and fittings are included in 12-page catalog. Specific applications are described for these valves and fittings designed for pressures to 15,000 psi. Envelope dimensions and applicable tubing sizes are given for 28 components listed. *High Pressure Equipment Company, Inc.*

Circle number (55) on reply card.

NFPA Pamphlet

Forty-six page standard for fire safety in solvent extraction plants has been published by the National Fire Protection Association. Solvent extraction process, largely used in extracting the oil from soybeans and other similar operations, presents a serious hazard by reason of the highly flammable solvents used. Such solvents, having fire hazard characteristics of gasoline, are used to remove the oils or fats and then must be separated from the oils and solids by another process also adding a hazard.

The NFPA pamphlet offers its recommendations as a guide to fire safety, stressing that compliance with the recommendations will minimize the hazard. *National Fire Protection Association.*

Circle number (56) on reply card.

Synthetic Surfactants

Twenty-four page bulletin describes Swift's line of synthetic surface active agents and detergents for industry. Identified by brand name "Solar," products include various forms of liquid concentrates for wetting, emulsification, suspension, dispersion, etc., and solid materials for use as detergents, wetting agents, emulsifiers, etc. Bulletin gives chemical and application specifications for over ten materials. *Swift & Company.*

Circle number (57) on reply card.

Burner Design Folder

Six-page folder on exclusive mechanical pressure atomizing oil and nozzle-mix gas burner includes 3 full-page wash drawings which describe complete construction features and principle of operation of combination oil and gas burner with which Continental automatic "package" boiler is equipped. Flow of both main fuels and primary and secondary combustion air supplies are clearly pictured. Flame monitoring and control systems are shown in detail. *Boiler Engineering & Supply Company, Inc.*

Circle number (58) on reply card.

Heat Transfer Folder

Heat transfer equipment is described in new condensed bulletin which points out predominant feature of Brown Fintube's equipment – patented fintube. It has 5 to 10 times heat transfer surface area of ordinary tubing. Unique feature of heat exchangers is ability to be used for any duty by reassembling group of hairpin sections into new series-parallel arrangement. *Brown Fintube Company.*

Circle number (59) on reply card.

Catalytic Recovery Bulletin

Use of activated beauxite as catalyst for recovery of 99.77 percent pure sulfur from H_2S is described in a new bulletin. The 4-page, 4-color brochure lists advantages of Porocel Corporation's catalysts in sulfur recovery during the Claus reaction. Simplified flow diagram is included, as are photographs of actual installations and Porocel sulfur recovery catalysts, shown full size. Characteristics of catalysts are given in tabular form. *Porocel Corporation, subsidiary of Minerals & Chemicals Corporation of America.*

Circle number (60) on reply card.

Welding Equipment Catalog

Arc welding machines are described and illustrated in 24-page, 2-color catalog. Comprehensive catalog includes complete specifications and ordering information on gasoline and diesel engine driven welders, engine driven welder-power combination units, electric motor driven arc welders, rectifier type welders, transformer type welders, combination transformer-rectifier type welders, a-c and d-c inert-gas-shielded arc welders and a complete line of automatic and semiautomatic welding equipment. Catalog also describes a line of induction heating equipment, pipe thawing equipment and a power source for cutting and gouging. *Hobart Brothers Company.*

Circle number (61) on reply card.

Nickel Alloy Guide

Compact and efficient guide to major nickel-containing casting alloys presents condensed, informative data on range of properties offered, industries served, and general applications for each of alloys included. Six-page fold-out table briefly pinpoints important properties of each alloy and its uses. The 27-page booklet is available free of charge. *The International Nickel Company, Inc.*

Circle number (62) on reply card.

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

REFINING PERSONALS

▸ Appointed to new executive position of product director for petroleum chemicals and functional fluids at Monsanto Chemical Company is **Reinhard S. Wobus,** former technical production manager of the organic chemicals division.

▸ **D. L. Fridley** and **G. W. Lowe** are new members of technical division at Humble Oil & Refining Company's Baytown, Texas, refinery, and **W. S. Vorhaben** has returned from military service. **J. K. Nickerson** and **B. G. Corman** have joined research and development division at Baytown.

▸ **Seymour W. Ferris** has been appointed research associate in the research and development department of Sun Oil Company. **Ivor W. Mills** was appointed to succeed Ferris as section chief for industrial products in product development.

▸ In recent appointments within Diamond Alkali's Chlorinated Products Division, **Z. A. Stanfield,** technical superintendent at the company's Belle, West Virginia, plant, transfers to Greens Bayou plant in Houston, Texas, area in the same capacity. Named to succeed him is **D. R. Pulver,** senior engineer with the technical staff in Cleveland, Ohio. Replacing Pulver is **V. C. Cayton,** process engineer at Deer Park, Texas. **G. E. Taylor** joins the division to fill Cayton's post.

▸ **John P. Purcell** has been named operations coordinator in the Eastern region office of Du Pont's Petroleum Chemicals Division. He will coordinate services related to safe, efficient handling of tetraethyl lead and other petroleum activities. **Robert B. Bothwell,** former operations coordinator in the Eastern region, has been transferred to the division's Gulf Coast region as sales service representative in the Houston, Texas, area. **Richard R. Golding,** who has been sales service representative in north New Jersey, has moved to division headquarters in Wilmington, Delaware, as technical assistant to the operations section.

▸ **Thomas M. Lumly,** founder of The Refinery Engineering Company and its president for nearly 18 years, has resigned. **Woodman (Woody) Perine,** vice president of Vitro Corporation of America, Treco's parent firm, will succeed Lumly as chief executive.

▸ Signal Oil and Gas Company has appointed **Richard L. Cook** general superintendent in charge of all gas plants. Cook, who has supervised operations of Signal's gas plant at Tioga, North Dakota, since 1954, joined the company in 1953 as field engineer. In an organizational change at the Tioga plant, **Harold Severson** has been named district manager in charge of the office, **Fred W. Norton** has been made superintendent of operations, and **Robert R. Dewell** will be in charge of operations and plant progress.

L. S. Beeler

R. S. Edwards

W. H. Montgomery

▸ In expansion of the marketing organization at Reynolds Metals Company, chemical and petroleum markets, formerly combined under one manager, **L. S. Beeler,** will each have its own manager. Beeler will head the new chemical process industries market and **R. S. Edwards,** formerly divisional industrial sales manager at Dallas, Texas, will head the petroleum market.

▸ **William H. Montgomery,** general manager of employee relations of Socony Mobil Oil Company, Inc., for the past 12 years, has been appointed general manager of the manufacturing department of Mobil Oil Company.

E. K. Ketcham

▸ Consolidation of Anderson-Prichard Oil Corporation's sales activities under direction of one vice president has been announced. **E. K. Ketcham,** former vice president, refined sales, was appointed vice president of marketing upon retirement of **C. H. Dresser,** vice president, industrial sales. **W. J. Sutton** will continue as general sales manager, refined oil sales, with **T. A. Eustice** as assistant. **R. S. Ketcham,** manager, asphalt sales, will remain as head of this division. New manager, solvent sales division, is **C. A. Gault.**

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SEALING COMPOUNDS

Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion, joint seizure.

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The super-penetrating rust solvent

LOOSENS

rusted bolts, nuts, screws, 'frozen' parts

Liquid Wrench works *fast*...yet is absolutely safe for all metals and alloys.

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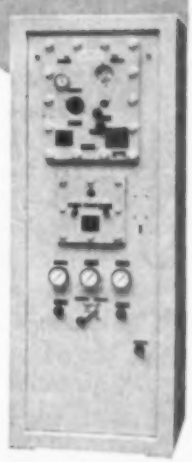

Full scale on most sensitive range,

to one milligram of water per liter of liquid. To 10 p.p.m. of moisture by volume in gases.

Direct reading scales—no computation necessary.

Includes novel self checking features.

Explosionproof Universal Model W. (Other models including portable models for moisture in gas are available.)

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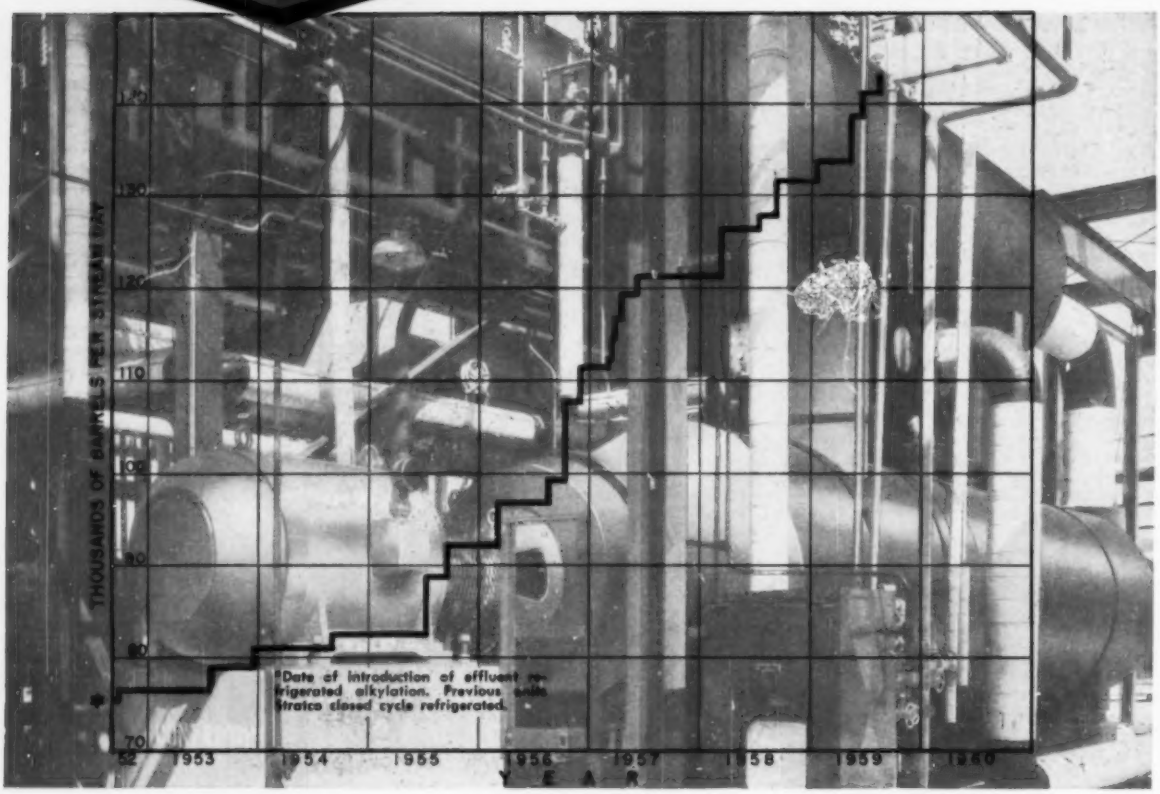
EFFLUENT REFRIGERATED ALKYLATION*



Charting An Outstanding Record of Installations

Which type of alkylation process is the most economical and efficient? According to a majority of the refiners who have installed alkylation plants in recent years, the answer is Stratco Effluent Refrigeration. The chart above traces the growth of Stratco Effluent Refrigeration since the process was introduced in late 1952. Each step on the graph indicates another plant contracted and its capacity. In this short period of time 46 units, with a total design capacity of 64,220 BPSD have been installed in 23 plants throughout the world. The trend toward effluent refrigerated alkylation is readily apparent. The Stratco process may be used to alkylate isobutane and propylene, butylene or amylene, either separately or as combined streams. Flow diagrams and electronically computed heat and material balances are available quickly and without charge from Stratco.

REPRESENTATIVES

D. D. Foster Co., Pittsburgh
D. D. Foster Co., S. Charleston, W. Va
Lester Oberholtz, Los Angeles
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We cooperate with your contractor in plant design

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This pipeline man wanted to know:

WILL A BELL SAVE ME MONEY?

At some point, most pipeliners take a long look at their ordinary equipment and the thought comes to mind: What about a helicopter? In the case of this Oklahoma construction company, the boss was looking, also, at a contract just signed . . one calling for a 30-inch gas line across 343 miles of mountains in Alabama, Tennessee and Kentucky.

What the company did was *charter* a Bell. From there on, discovery followed discovery. On the first day out, after spotting a broken-down bulldozer, the Bell flew in mechanics and parts for quick repair. Then it started shuttling spread-superintendents to work sites, helping engineers keep track of progress, jumping here and there to haul in a tool or bring out an ailing workman. Just its hovering presence gave the entire job the feel of being under control.

This Oklahoma company now uses a Bell on four other spreads, in such new-found ways as hunting out roads, ferrying survey crews, flying in inspectors and personnel. How about the value of a Bell in your own operation? Charter is a low-cost way to find out. We'll be glad to send you names of Charter Services in your area, along with additional information on Bell models and other convenient ways to try the Bell. Simply write Dept. 35L, Bell Helicopter Corporation, Fort Worth, Texas.

BELL Helicopter CORPORATION

FORT WORTH, TEXAS

SUBSIDIARY OF BELL AIRCRAFT CORPORATION

in close quarters...

...around curves

cross country...

* Both machines dig from 10" to 24" wide and to 5'6" deep. Model 773 has extra-wide crawlers for jobs where machine width is not a factor.

two new Barber-Greenes ..."digginest" ditchers in their size range*

These two new Barber-Greene wheel ditchers have the all-around "digability" to make fast work of any ditching job in their size range—jobs that call for the utmost in speed, flexibility, ruggedness *and economy*. They include general utility work such as gas, water, electric and telephone services . . . drainage and excavating . . . plus the many other applications that require a speedy, dependable ditcher.

Many new, exclusive features—not available on any ditchers in their range—enable the Models 772 and 773 to dig up to 25% more ditch per day. For example, fewer moving parts mean low-cost, low maintenance operation . . . fully guarded drive chains and automatic overload protection give maximum safety . . . dual-range Hydra-Crowd transmission provides infinitely variable digging speeds from 0 to 28 f.p.m.

Write for new bulletin **describing how the many exclusive Barber-Greene advantages enable the new 772 and 773 to dig up to 25% more ditch per day.**

59-4-D

Representatives in Principal Cities of the World

Barber-Greene BG

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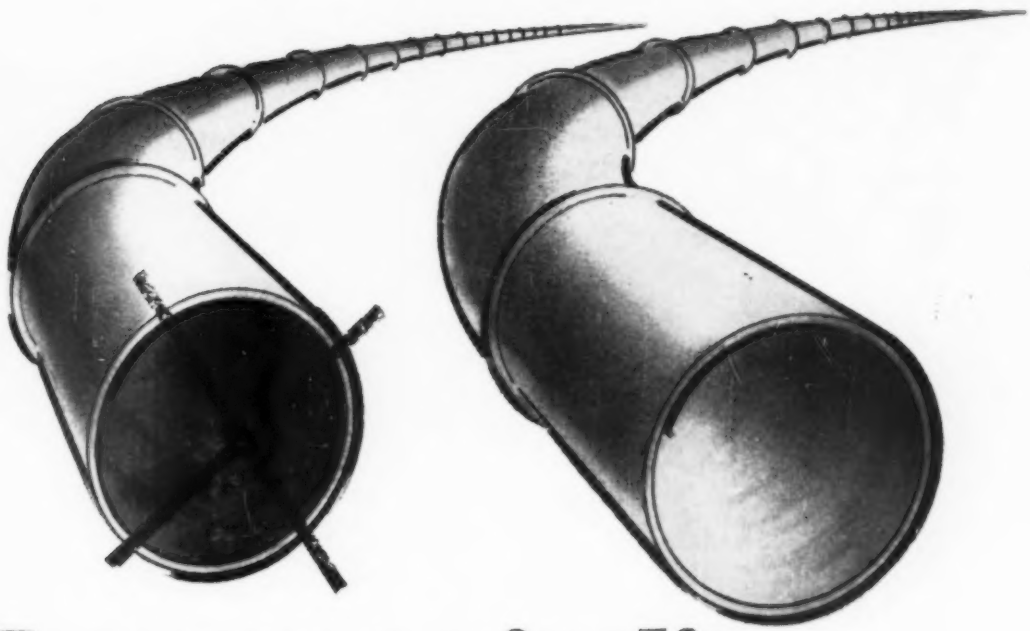
Plants in DeKalb, Illinois, Detroit, Canada, England, Brazil, Australia

CONVEYORS...LOADERS...DITCHERS...ASPHALT PAVING EQUIPMENT



Keep your pipeline corrosion-free with Solvay Sodium Nitrite

To prevent corrosion right from the start, add Solvay® Sodium Nitrite in low, economical concentration to the products you're moving when you open a *new* pipeline. (Your pipe stays as clean as the cross-section on the right!) You can also use it effectively on older, now-in-service lines—to arrest corrosion and prevent further internal damage.

Solvay Sodium Nitrite forms an invisible gamma oxide film that protects the inner pipe surface from attack by occluded water. It is readily injected by a proportioning-type pump operated by the fluid that is being pumped.

Solvay Sodium Nitrite has several important advantages over other inhibitors. It costs less than most organic compounds. Being soluble in water and insoluble in petroleum products, relatively small amounts are needed. It will not contaminate these products. It will not react with most impurities or organic inhibitors in other petroleum products that may be in the same line.

For more facts and a test sample, mail the coupon now to Solvay.

Sodium Nitrite • Caustic Soda • Calcium Chloride • Chlorine • Chloroform
Caustic Potash • Potassium Carbonate • Sodium Bicarbonate • Soda Ash
Ammonium Chloride • Methyl Chloride • Ammonium Bicarbonate • Vinyl Chloride • Methylene Chloride • Cleaning Compounds • Hydrogen Peroxide
Aluminum Chloride • Mutual® Chromium Chemicals • Snowflake® Crystals
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Please send:

☐ A. Test sample of Solvay Sodium Nitrite
☐ B. Booklet—"Sodium Nitrite for Rust and Corrosion Prevention"

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Merry Christmas, Everyone!

FROM YOUR COLLINS MICROWAVE SALES ENGINEERS

● L. W. Proctor—Dallas

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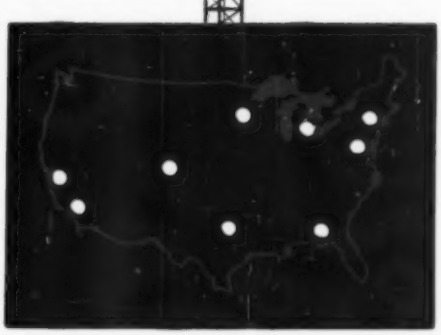
MICROWAVE AND CARRIER



This chorus usually sings the praises of Collins Microwave and Carrier Equipment. They are the 14 sales engineers who represent Collins' Texas Division to utilities, railroads, telephone and pipeline companies. During this holiday season, they extend Christmas greetings from the 1,750 employees of Collins' Texas Division to Collins' friends everywhere.

COLLINS RADIO COMPANY
TEXAS DIVISION · DALLAS, TEXAS

COLLINS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Foxboro Capacity Dynalog* Recorder, located upstream from receiving station, records dielectric constant of pipeline product — telemeters it ahead to delivery point.

New Accuracy in Interface Detection!

Unique Foxboro System profiles interface in advance — helps reduce product contamination at switch-over

Now your pipeline dispatchers can accurately chart the shape of an interface in advance — pinpoint their switch-over of product runs!

The Foxboro Pipeline Interface Detection System is based on the fact that even slight differences in grades of petroleum products have measurably different dielectric constants. Sensitive capacity Dynalog* Recorders measure this difference, both at the pipeline delivery station, and at a point one or two miles upstream. Foxboro Teletax* Telemetering brings the two measurements together on a single chart at the delivery station.

From the shape of the upstream record, the dispatcher selects the best cut point well before the interface arrives, and sets index at this point. When station interface record matches index, switch-over is made.

Foxboro Interface Detection eliminates sampling and guesswork — holds product contamination and loss to a new minimum. Systems in use today include both dual-measurement and single-measurement systems. Ask your nearby Foxboro Field Engineer about them, or write for Bulletin 20-11. **The Foxboro Company, 3812 Norfolk St., Foxboro, Massachusetts.**

*Reg. U.S. Pat. Off.

2-pen Capacity Dynalog Recorder, at delivery station. One pen records dielectric interface measurement telemetered from upstream station. Second pen records measurement at delivery station. From upstream record, dispatcher selects best cut point, and aligns index with this point on chart. When second pen matches index, switch-over takes place, either automatically or manually

FOXBORO

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INTERFACE DETECTION SYSTEMS

The all new Insley **M**
for the men who build pipelines

● When the trench hits rock, hills or swamp, call in an Insley M. From one trouble spot to the next, the new Insley M gets the tough jobs done—and fast. The Insley M's heavy-duty components are designed for these severe operating conditions . . . for maximum dependability . . . for maximum production.

Take advantage of the pipeline "thinking" that's designed into the Insley M. Ask your Insley Distributor about this top-performing backhoe or contact Insley direct.

THERE'S AN **INSLEY** WORKING NEAR YOU

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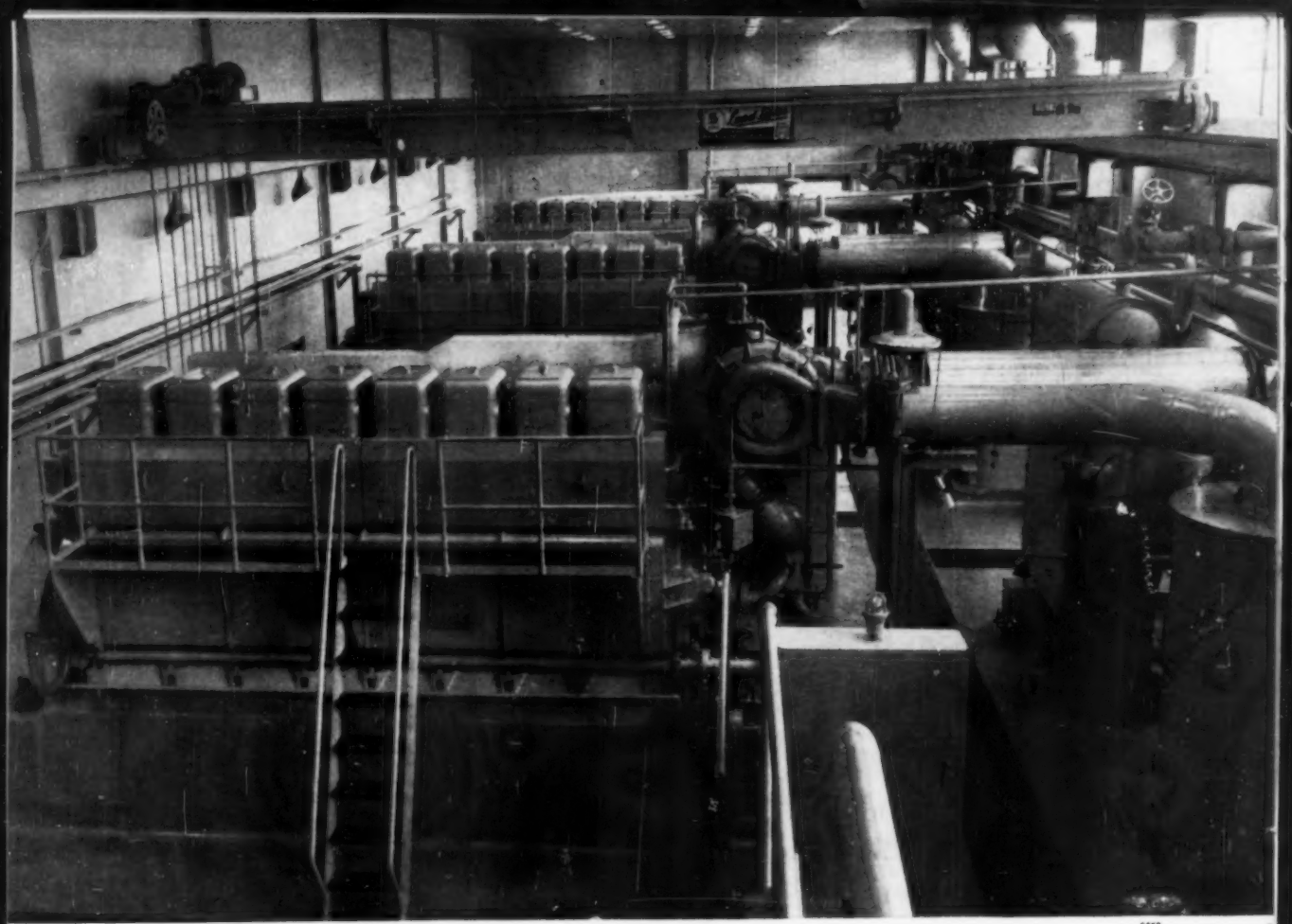

Pipe line engines by Nordberg

Fourteen Nordberg four-cycle diesel engines, totaling 26,680 horsepower, serve the pumping stations along the Lakehead Pipe Line Company, Inc. line. Eight engines are rated at 2000 hp, and six are rated 1780 hp each. The pipe line extends from the Canadian border to Superior, Wisconsin, and from there to the Canadian border at Sarnia, Ontario.

NORDBERG MANUFACTURING COMPANY
MILWAUKEE 1, WISCONSIN

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WASHINGTON • TORONTO • VANCOUVER • JOHANNESBURG • LONDON • MEXICO D. F.

PROTECTION *is our business*

NICOLET ASBESTOS PIPE LINE FELTS are formulated and manufactured to provide the best pipe line protection possible.

The finest raw materials, plus rigid quality control in manufacture . . . "from Nicolet Asbestos Mine to Pipe Line" . . . is your assurance of uniformity in product and performance.

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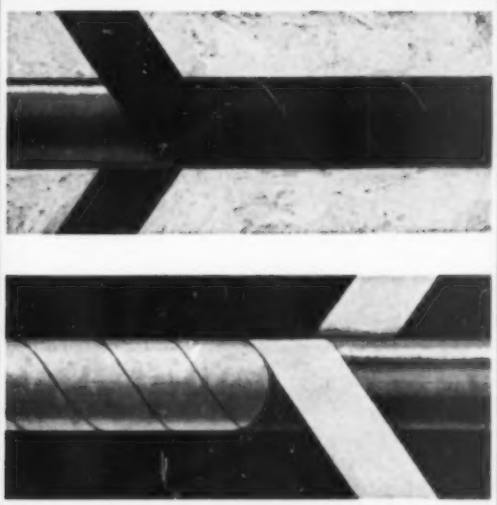

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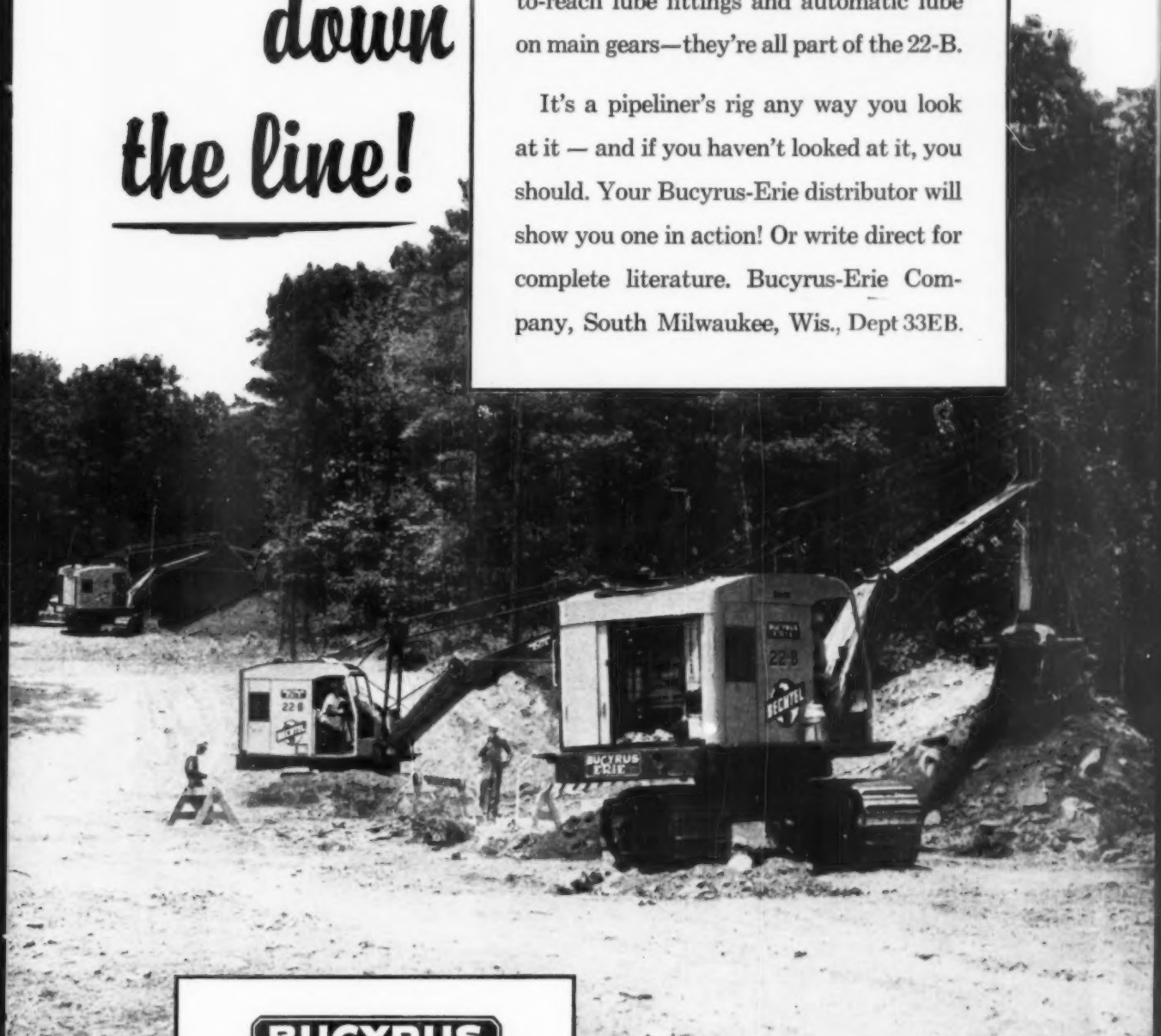

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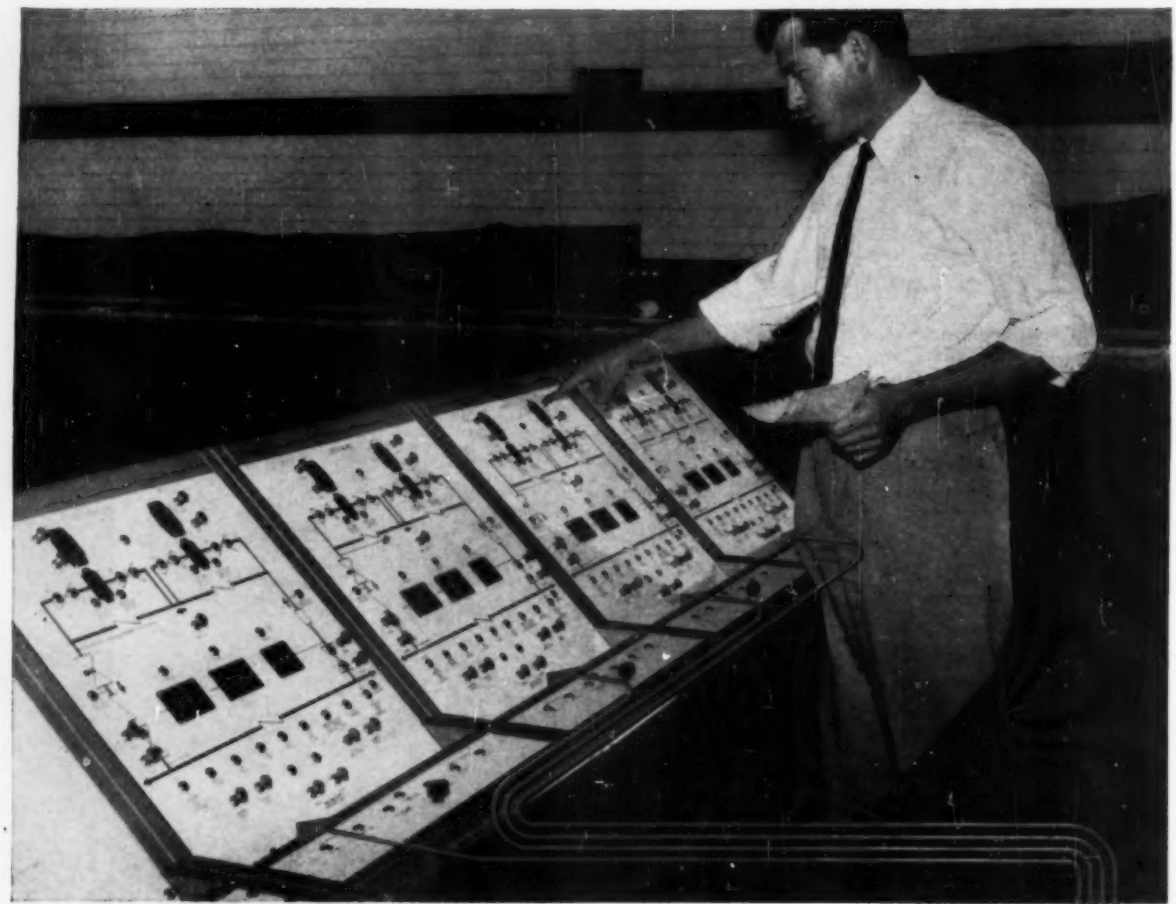
Union Centralized Transport Control pays



LOS ANGELES CONTROLLING OFFICE—The heart of the whole operation is in Los Angeles where one man at the control console can supervise the operation of four unattended pump stations 643 to 804 miles away. The operator has complete information before him showing conditions all along the line.

PHOENIX
Output Terminal

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APACHE
Unattended Booster Pump Station

REMOTE CONTROL—Either pumping unit at any one of the four booster stations can be started or stopped from Los Angeles. The sequence in opening and closing valves and starting and stopping pumps is all handled automatically and correctly by the control system.

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off for Southern Pacific Pipe Lines

Push a button in Los Angeles and four pump stations throb into action out on the desert over 600 miles away

Union Switch & Signal equipment controls operating sequence and telemeters operation of 33,000 bbl/day products line

FLEXIBILITY and fail-safe operation are the keynotes of the new pipeline system operated by Southern Pacific Pipe Lines, Inc. The line is used to transport refined products such as gasoline, jet fuel, diesel oil, etc., from El Paso, Texas, to Tucson and Phoenix, Arizona. All Centralized Transport Control equipment for four unattended booster stations was supplied by Union Switch & Signal.

REMOTE or LOCAL: All four booster stations are normally controlled from Los Angeles. Any station can be controlled locally, when desired. In any case, continuous pressure and suction readings are displayed on the console at Los Angeles and automatically recorded every fifteen minutes by an automatic typewriter. Any malfunction, at any point in the system, is indicated on the console. The equipment affected is shut down automatically and cannot be started again until the trouble has been cleared.

COMMUNICATION: Four telegraphic-type communications lines, owned by Southern Pacific, are used to transmit control codes to the stations and telemetered information back to Los Angeles. Each line serves one station. An additional commercial communications line serves as a stand-by for all four stations. Signals are coded to prevent noise or interference from causing faulty operation or indication.

MAXIMUM EFFICIENCY: The Centralized Control system, designed and installed by Union Switch & Signal Division of Westinghouse Air Brake Company, cuts down the chance for expensive error. It keeps the Southern Pacific Scheduling Department in Los Angeles informed, at all times, of exactly what is happening in the field. It speeds operation, adds security and reliability.

Union Switch & Signal has designed many successful custom systems for pipeline companies. And now out of that experience, it has developed standardized central control systems that cut costs, add flexibility, and save space, as well as making pipeline control extremely reliable.

"Pioneers in Push-Button Science"

UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
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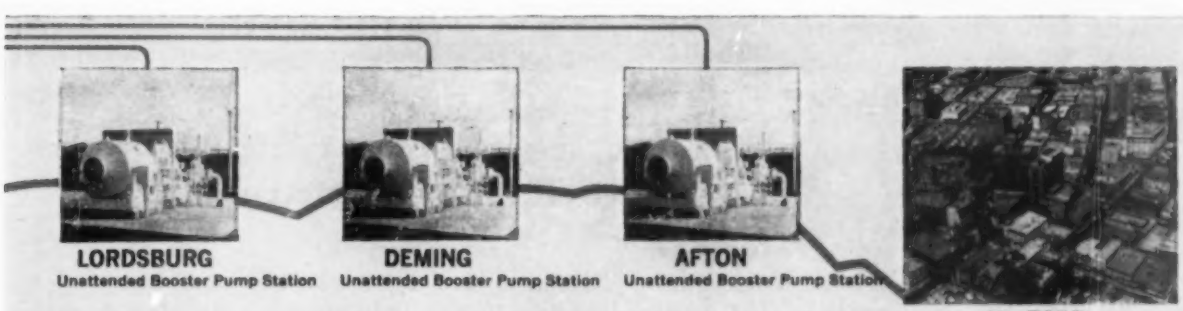

LOCAL CONTROL—Operation also can be controlled automatically at the pump station. Or the station can be run manually. The choice is up to the local station. But Los Angeles always knows which mode of control is being used and always receives a continuous flow of system information.

THE FUTURE—Southern Pacific Pipe Lines, Inc. can already see opportunity to make this system more automatic and more efficient. They plan, in time, to be able to let stations adjust automatically to proper unit operation when an upstream or downstream station goes off the line.

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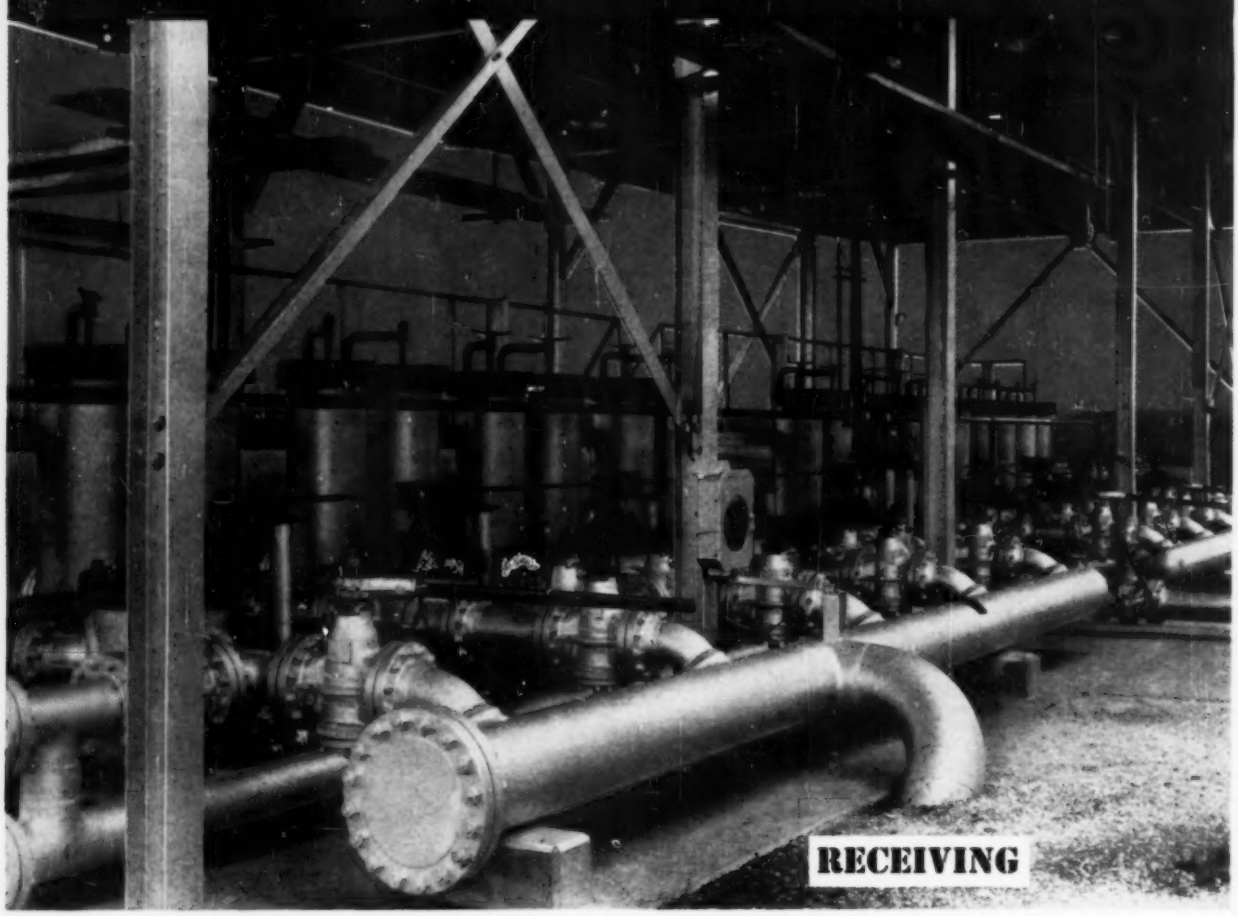
A major products pipe line company

counts 'em COMING



4-company oil "bank" keeps accurate ledgers on product deposits and withdrawals

With four contributors working one terminal, accuracy is a must. And when this Gulf Coast installation was planned, the natural choice for keeping records straight was an A. O. Smith meter system.

The four lines feed through four separate A. O. Smith meter banks that register input within hundredths of a percent. A second set of meters measures and records individual deliveries from the product "pool" to the big 16-inch line.

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This Gulf Coast terminal is just one example of job-site benefits that can be duplicated for you by A. O. Smith. For more information, contact your A. O. Smith meter man or write direct.

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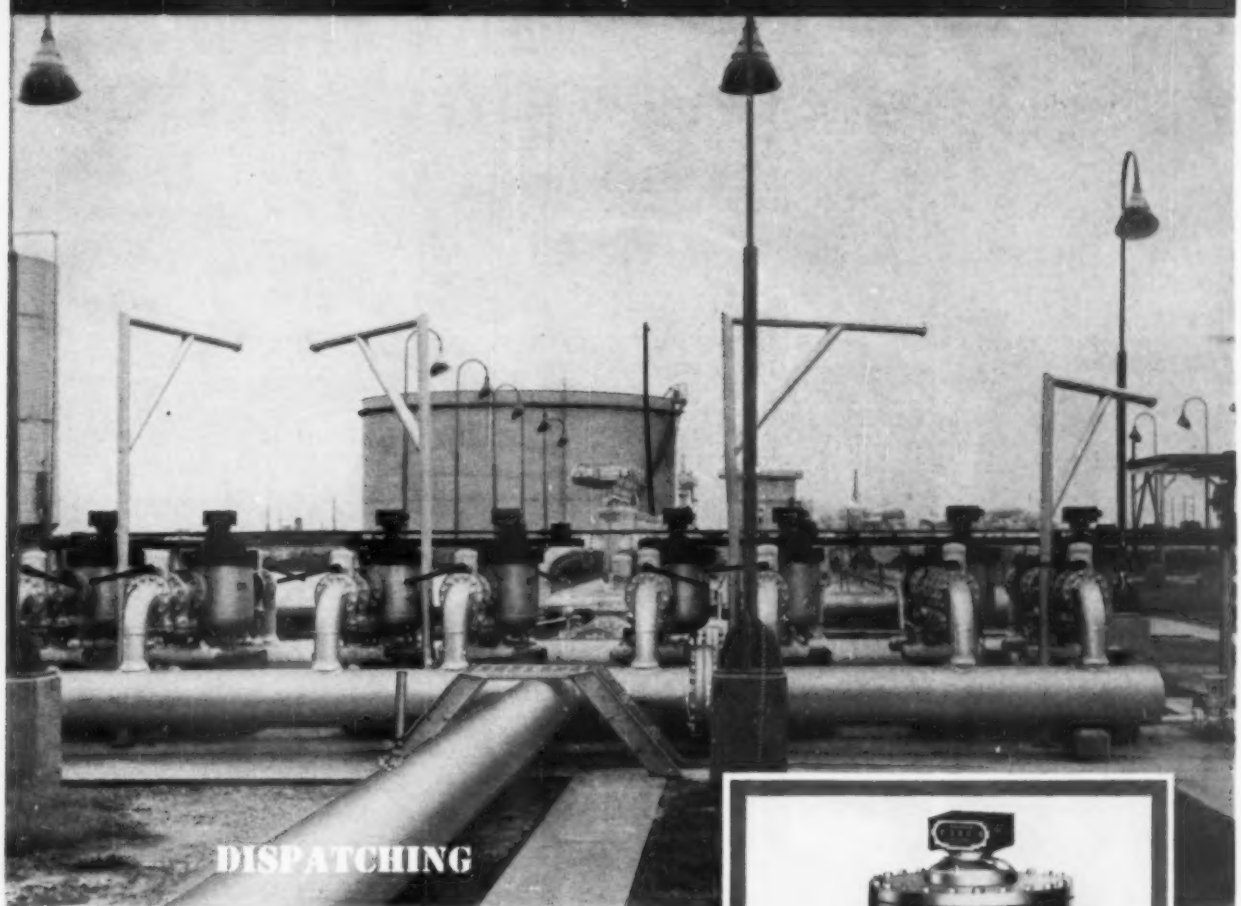
and GOING



A. O. Smith measures your needs — then recommends the metering setup that gives you the most accurate and economical service. Like this company, you can benefit by depending on A. O. Smith for meters.

Through research . . . a better way

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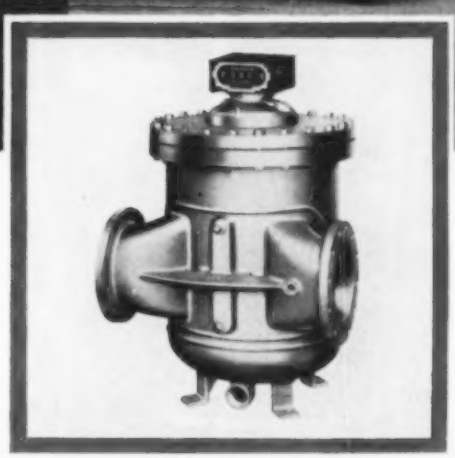

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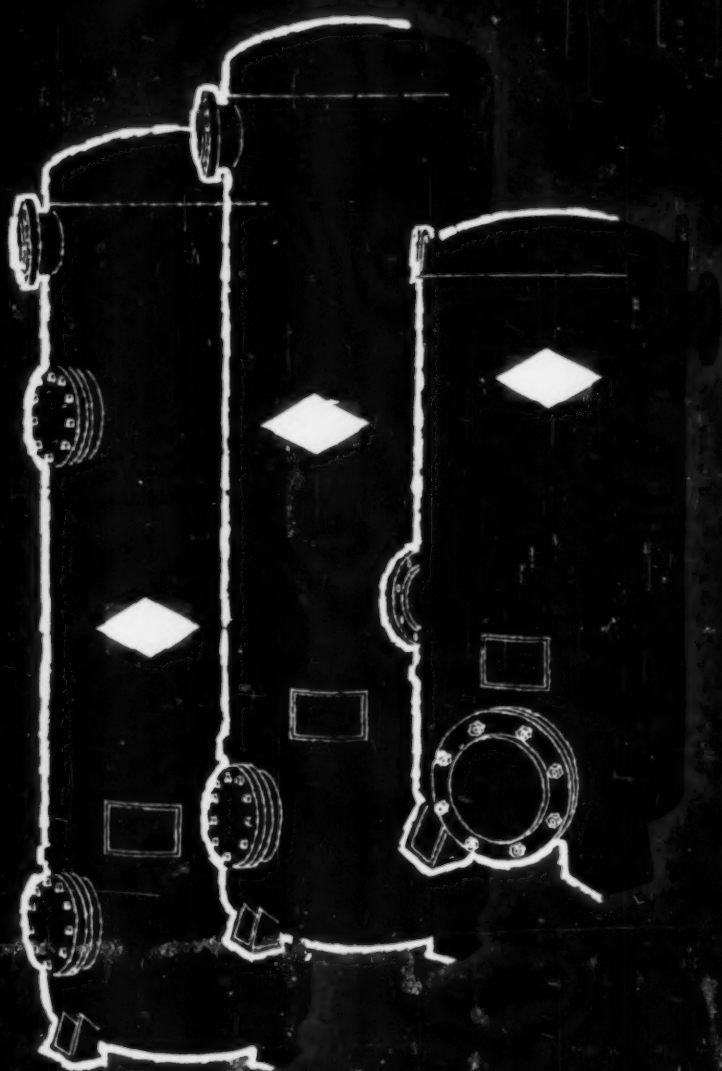

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meet widest operating conditions

MP *(multi-phase) handles loads from 5% to 100% of rated capacity . . .* holds oil loss to under .03 gallons per million standard cubic feet of gas . . . traps virtually 100% of dust over 3 microns, 80% of smaller and sub-micron particles.

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TYPE H *(high capacity) handles loads from 50% to 100% of rated capacity . . .* provides the efficiencies of the MP. Both Type-H and MP models are available in 18″ to 72″ diameters, capacities to 18,000,000 standard cubic feet per hour at 1000 psig.

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SERIES L-H *(low height) for systems with pressures less than 300 psi.* Similar in operation to the large units, the L-H cleaners are often installed in parallel: one or two units for existing loads, others to meet additional demands.

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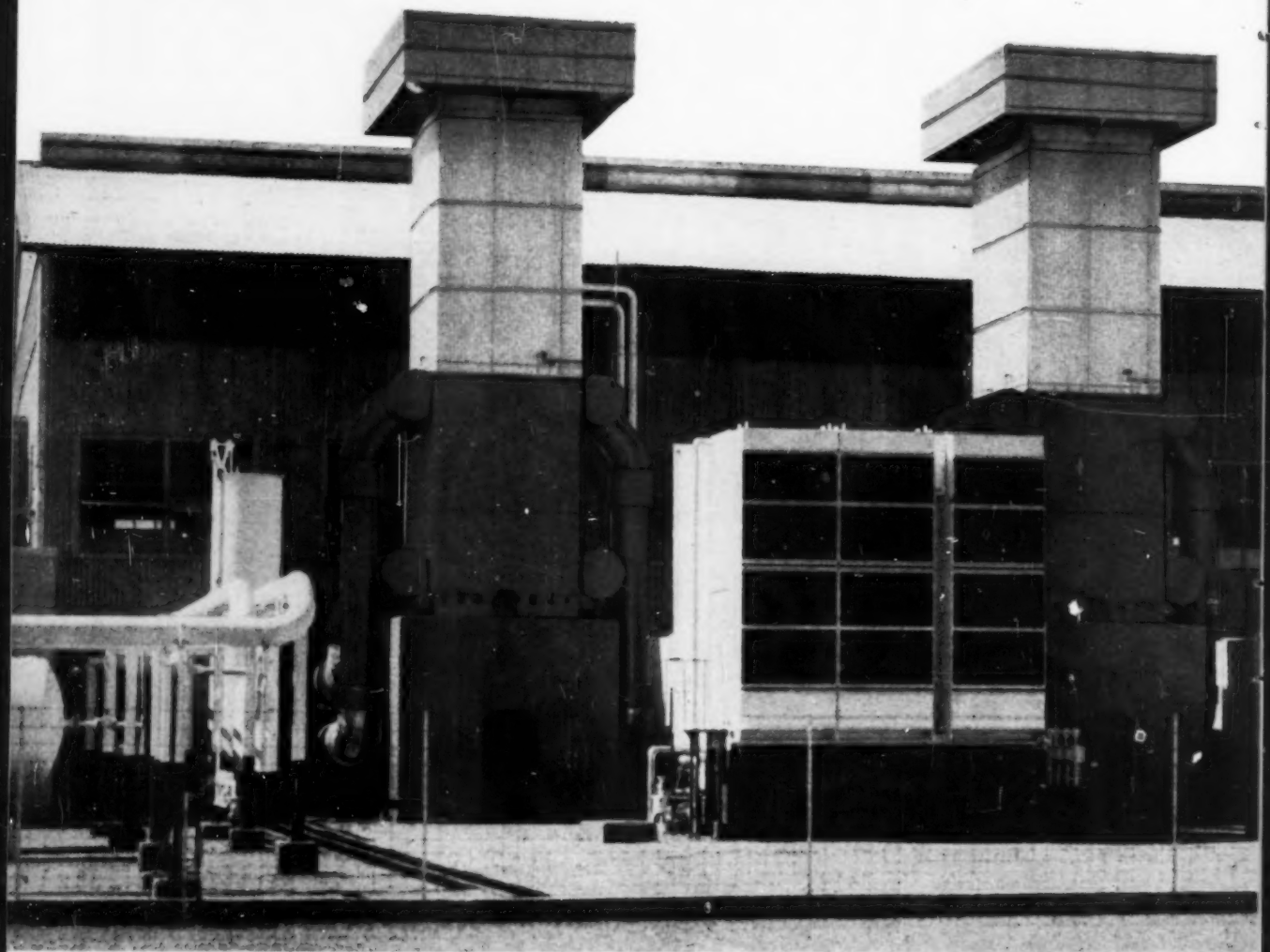
IT TAKES LESS THAN 500 MANHOURS TO INSTALL A **FIN-PAK®**



Dual Fin-Pak heat exchangers at El Paso Natural Gas Company's compressor station at Caprock, New Mexico. The two 5,000-hp gas turbines at the Caprock station pump an average of 12,000 CFM, 24 hours a day.

Fin-Pak's prefabricated design, light weight and compactness cut installation time and labor costs to a minimum. On a typical 5,000-hp gas turbine cycle, for example, fewer than 500 manhours are required for *complete* installation of a Fin-Pak.

And installation economies are just the beginning. In operation, a Fin-Pak can cut your fuel bill by as much as 32%*, because it recovers up to 80% of the heat from the turbine exhaust and returns it to the combustion air.

And maintenance is a cinch with the Fin-Pak. It has short, straight-through passages. Occasional cleaning with compressed air is *all* the maintenance a Fin-Pak needs. **One last thought:** a gas turbine station requires about 80% *less* plant maintenance personnel than a station of equal capacity operating diesels, steam turbines or gas engines. For complete details, call or write Air Preheater.

*A Fin-Pak with a designed efficiency of 75% in a gas turbine cycle at 6 to 1 pressure ratio and a turbine inlet temperature of 1500°F.

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CONSTRUCTION FEATURE

Technical and Manpower Problems Being Encountered in Laying Sahara Pipeline

Important outlet for Edjele-Zarzaitine area will be ready to load tankers at LaSkhirra, Tunisia, on the Mediterranean by October 1, 1960

F. H. Korn *Compagnie des Transports par Pipe-Lines au Sahara (TRAPSA)*

RAPID DEVELOPMENT of oil production in the Sahara Desert has resulted in the need for two large-diameter pipelines.

The longer of these is being built by the Compagnie des Transports par Pipe-Lines au Sahara (TRAPSA). This company was formed to transport to the Mediterranean Sea crude oil originating in the oilfields of the Edjele-Zarzaitine area, bordering the north portion of the Fort-Polignac Basin. These oilfields are being developed by the Compagnie de Recherches et d' Exploitation de Pétrole au Sahara (CREPS), affiliated with the Régie Autonome des Pétroles (RAP), a French concern. TRAPSA, the pipeline company, is a 100 percent subsidiary of CREPS, the producing company.

Discovery of the Edjele field by CREPS in 1956 was the first Saharian discovery. It has been followed by several others. By 1961, CREPS expects to produce 160,000 bbl per day and anticipates that production may double within a few years.

The problem of transporting this production is being solved with the construction of a 24-in. diam pipeline, 780 km (485 miles) long. This line will carry 150,000 bbl per day when it begins operating in 1960. Optimum capacity will be approximately 340,000 bbl per day.

Two Routes Considered

Originally TRAPSA considered two possible routes: One 685 km (425 miles) long terminating at Zuara, Libya; the other running through the Tunisian territory to the Mediterranean, terminating either at Zarzis, between the Island of Djerba and the Libyan border, for a total pipeline distance of 723 km (449 miles), or at La Skhirra, Tunisia, north of the Gulf of Gabes, a total pipeline distance of 780 km.

The terminal in Tunisia was chosen despite the disadvantage of the longer pipeline distance. This was decided because the maritime features offered by the terminal site at La Skhirra was unique in the Mediterranean seacoast from Gibraltar to Mercina.

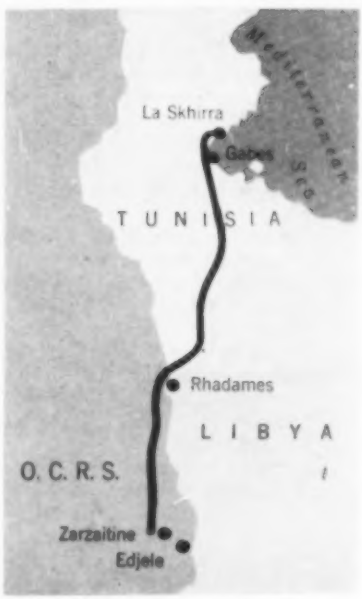
Starting point of the pipeline is on the table-land of Zarzaitine in In Amenas. In Amenas is a central location in the CREPS oilfields. It is in a region where drinking water exists at a reasonable depth. A nearby "sebcra" offers exceptional facilities for the construction of a landing strip for the large Breguet aircraft, and a good setting for important auxiliary installations and housing for the station personnel.

From In Amenas the pipeline proceeds northward in a straight line to the Libyan town of Ghadames, which it bypasses before crossing the Tunisian border at 280 km (174 miles) from its originating point.

In Tunisia the line curves eastward and follows the Libyan border to Mechiguig. Here the pipeline goes around the Grand Erg Oriental and continues northward, bordering the 10 degree Meridian, to its terminus on the Mediterranean at La Skhirra, approximately 80 km (49.7 miles) southwest of Sfax and 55 km (34 miles) north of Gabes.

Construction Organization

For the construction work TRAPSA took advantage of the worldwide experience of the Bechtel organization while using French equipment and French pipeline contractors. A contract for technical assistance was signed October 15, 1958, with Bechtel Méditerranéenne S. A., subsidiary of Bechtel Corporation. This contract entrusted Bechtel Méditerranéenne S. A. with the engineering and supervision of construction of the pipeline. Meanwhile TRAPSA was placing orders with French mills for the necessary pipe and negotiating contracts with French contractors. These firms were given the construction of the tanks, the power station, the initial pump station, and the port and loading station. The pipeline itself is being laid by GREP and a group of firms headed by an affiliated firm of Grands Travaux de Marseille.



Route of pipeline from Edjele-Zarzaitine area to La Skhirra, Tunisia.

(Map courtesy Bechtel)

Construction Problems

Construction of the pipeline raised both technical and manpower problems.

In the matter of technical problems there were two important natural obstacles. At approximately 50 km (31 miles) from its origin, the line crosses the 140 m (460 ft) high Tinrhert cliff, which could not be bypassed without considerable extension of the pipeline. It was therefore crossed by taking advantage of a recess in the cliff, with heavy blasting work opening the way for the pipeline and the supporting road.

The second serious impediment was the Grand Erg Oriental in Tunisia. Following a straight line the pipeline would have crossed the eastern extension of the Erg; however, the technical difficulties and the cost of the operation led to bypassing through the narrow channel bordering the Libyan frontier between Fort-Saint and Mechiguig. The highest dunes (sandhills) were thus avoided, but it was necessary to cross over some dunes by cutting and filling with bulldozers.

The remaining crucial point was the water. Although it may seem paradoxical, the problem was not serious along the Saharian portion of the line, but it was in southern Tunisia where water is scarce and contains a large percentage of salt, which made it unusable for requirements of TRAPSA's installations.

On the human level, the construction in the Saharian region naturally raised serious problems. Their solution is now familiar to French enterprises, which, following five years of working in the desert, have adapted the equipment, housing, and way of living to conditions of the desert. The problem of labor faced an aspect slightly different in southern Tunisia where there is an over-population in relation to the local employment possibilities. Also, the average workman is not highly skilled. So, TRAPSA is endeavoring wherever possible to hire the maximum Tunisian Nationals in accordance with conditions of the local economy, giving priority to utilization of manpower over mechanical means.

Technical Characteristics

Operation of the system will be in three phases. Initially, with one pump station, capacity will be 150,000 bbl per day. This will be increased to 190,000 bbl per day with the addition of a second station, in Tunisia, and in the third phase, with four stations, 280,000 bbl per day will be transported. Eventually there will be a fourth phase of expansion, when addition of four booster stations will increase the capacity to 340,000 bbl per day. Each of the main line stations will be equipped with five pumping units, four of which can be in service at a time.

Tinrhert cliff was one of the most formidable natural obstacles. Taking advantage of a recess in the cliff, heavy blasting and bulldozers opened the way for the pipeline and the supporting road.

Design of the system embraces telescoping the pipe in four sections with three wall thicknesses in each section. One section will have pipe of two grades. The pipe is manufactured to specifications of API 5LX-52, except for one section (40 km (25 miles) ahead of the marine terminal, where the pipe is 5LX-42.

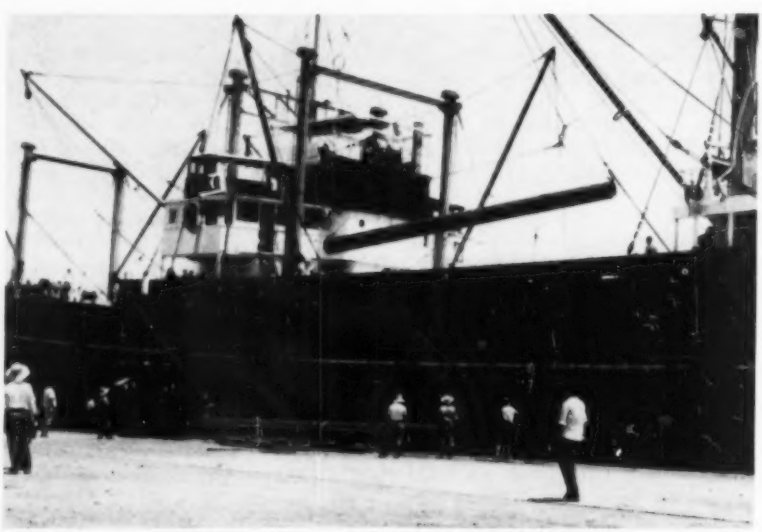
The pipeline is being buried with a cover of 60 cm (2 ft). In certain places, such as water crossings, roads, etc., the cover is of 90 cm (3 ft). Bypass valves are provided at the site of future pump stations, and section block valves are spaced along the line every 30 or 40 km (19 to 25 miles).

The pipe is coated with 3 mm (0.317 in.) of coal tar having reinforcing of glass fiber, and wrapped with asbestos felt. As a further protection, cathodic protection will be applied.

The pipe is being double-jointed for its entire length. A transport road for heavy transportation equipment has been provided for safety and efficient transportation.

Terminal and Stations

The terminal at the start of the line at In Amenas includes a tank farm for receiving crude oil originating from CREPS' oil fields. The crude oil will be segregated by type and will be batched through the line initially by one



Unloading pipe at Sfax from where it was transported to a double-jointing yard, then trucked to the right-of-way.

high pressure pump station, pumping at a rate fixed according to the production rate of the oil fields.

The first part of the work includes construction of seven floating roof tanks, with a nominal capacity of 117,000 bbl spaced 460 ft apart. The tank farm area has room for 12 tanks of a similar type. For reasons of security in case of fire the distance between the tanks has been made greater than is the usual practice.

The pump station at In Amenas will be the only one built during the first phase of the construction project. It will include five units, four initially with a unit capacity of 1500-hp placed in series, in one room of the main building. One unit only in service will provide for an output of 4,000,000 tons (30,000,000 bbl) per year. The addition of the three other units will raise this output to 7 to 7½ million tons per year.

A second room will be provided to contain all electrical, pneumatic, and control instruments. This room will be pressurized to keep sand and hydrocarbon vapors from entering the control room.

Operating and protection devices will be centralized in an operating room isolated from the pump room. Inside, a control panel will permit remote control of all main valves including the tank valves, isolating station valves, and pump suction and discharge valves. Control devices will permit automatic starting and stopping of each pumping unit with a single pushbutton.

Marine Terminal

The marine terminal includes a tank farm, a loading pump station for high loading rates, and marine installations needed for the mooring of tankers.

The tank farm will include six tanks of 35,000 cm (220,000 bbl) capacity each, initially, their number being progressively increased with the raising of production.

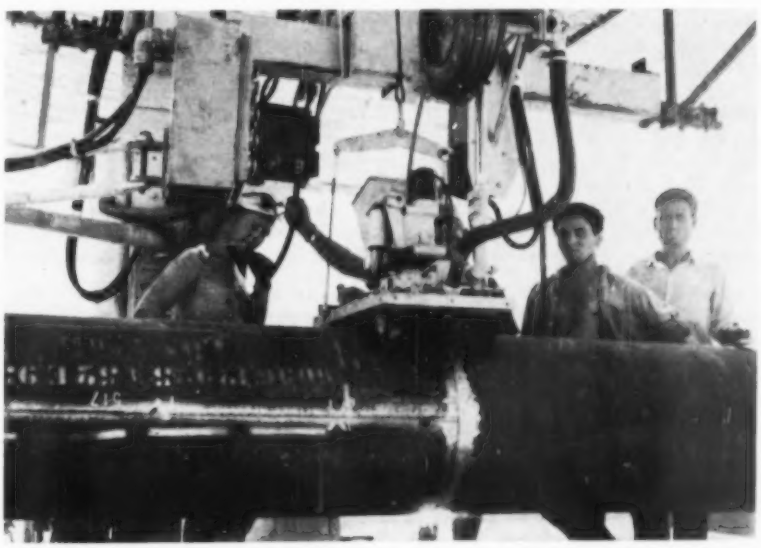
The favorable nautical condition at La Skhirra will make possible the loading of tankers at berths with regularity and rapidity not usually attainable at an unsheltered port. The berths will be connected to the land by means of a causeway approximately 1000 m (3280 ft) long, then a long pier will provide six moorings, two of which only will be built during the first phase.

Mooring of ships will be carried out on flexible dolphins to avoid any damage, although the roadstead is perfectly sheltered and the waves are never higher than 1 meter (3.28 ft). The berths will be accessible to tankers of 73,000 tons, and, after some dredging work in the roadstead access, to ships of 100,000 tons.

Ship-loading will be carried out with a pump station of high output, permitting a loading rate of 8000 cm (50,667 bbl) per hr. This will place TRAPSA first in comparison to other installations from the viewpoint of high loading rates. This output will be provided with centrifugal pumps of 1500 hp, three of which will be set at the time the pipeline goes into operation. This number will be increased to five when the maximum output is reached by the initial pump station.

Additionally, the terminal will include a deballasting station that will handle ballast at a rate of 4000 cm (25,333 bbl) per hr.

Heavy construction equipment on the dock at Sfax awaiting movement to the working spreads.



All pipe used in the system is being double-jointed automatically in a central yard.

Work Progress

Construction work being presently in its most active phase, it is difficult to determine work progress on account of swift changes from one day to another.

On September 1, 1959, at the tank farm of In Amenas, all engineering work was completed, the first three tanks were completely erected, hydraulic tests were being carried out, and four other tanks were being erected.

Final location of the pipeline and transportation road was completed at the beginning of May. The transport road was completed August 15 and is now in use, for the first time giving a direct liaison between Tunisia and Eastern Sahara.

It is interesting to point out that Tunisia had been so far completely isolated from the Sahara by the barrier

Constructing the causeway at La Skhirra, which is now completed.

of the Grand Erg Oriental. Passage of the first road convoys in the second fortnight of August between Tunisia and the Sahara marked an important event and is opening interesting economic prospects to Tunisia, which will be able to participate in supplying the Saharian work sites.

The 24-in. pipe arriving regularly in Tunisia and unloaded at Sfax is transported immediately to the double-jointing site prior to being trucked to the work site along the line. On September 1, 257 km (160 miles) of pipe had reached Tunisia. Transportation and stringing started in August and welding began October 1.

Two construction spreads are being used, laying about 80 km (50 miles) per month. These two spreads will meet in the vicinity of Fort-Saint at the Tunisian border. Trenching started on July 28 in In Amenas and on August 14 in La Skhirra.

In La Skhirra the causeway is completed for its full length, the work being terminated at the end of September following widening of the final levels. Pile-driving started on August 16.

TRAPSA completed the base facilities of the pipeline with the drilling of six water wells and the construction of four airstrips in addition to those TRAPSA is utilizing and maintaining along the line.

Completion of the pipeline and the pump station at In Amenas, the construction of which is to begin shortly, will be in June or July, 1960. This will permit tests of the pipeline and the loading of the first tanker on October 1, 1960.

This date will see the operation of a project that will provide in 1961 more than one-quarter of the French needs for petroleum, and a project that will hold high rank among the important international pipelines. ★ ★ ★

■ Tunnel Construction for River Crossing

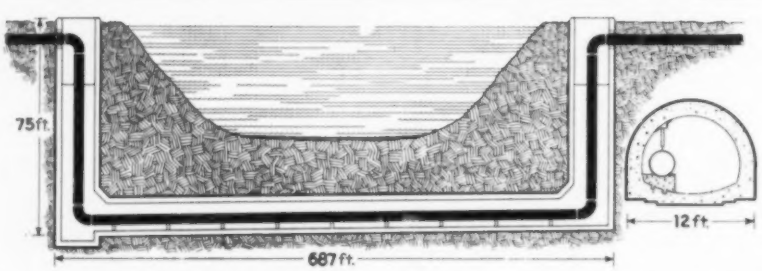
A TUNNEL of the type shown in the accompanying illustration has been installed by The Peoples Gas Light and Coke Company of Chicago to carry its pipeline under the Calumet River on its new Third Calumet Line between Joliet and Chicago.

Width of the tunnel is 687 ft, depth 75 ft. Top of the tunnel is 60 ft below the water surface.

The shafts and drift for the tunnel were excavated by hand, using jackhammers. Concrete for the outer shell of the tunnel drift was pumped in between outer wooden supports and a metal form, the floor being laid before the arch. The two vertical shafts also were concrete lined.

Pipe is supported on concrete piers and braced against the top of the drift by jack-screws welded in place. No special coating was used, only enamel and glass fiber wrap, the same as other sections of the pipeline.

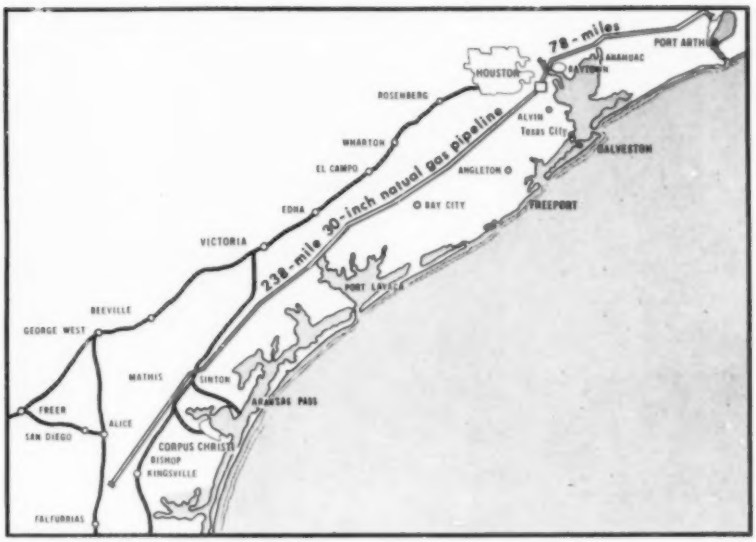
Provision has been made in the tunnel for future expansion of facilities, as can be seen by the cross-section in the illustration.



Artist's conception of tunnel under Calumet River for natural gas pipeline crossing. Cross-section at right shows how provision has been made for future lines as facilities expand.

Peoples previously has found this type of construction popular elsewhere on its system, at two locations on its transmission system and several places on its distribution system within the city of Chicago. It is the only one of the kind on The Third Calumet Line, however, five other river crossings being of the submarine type.

Peoples Gas and Chicago District Pipeline Company, a subsidiary, are completing a 60-mile line between Joliet and Chicago having a design capacity of 557,000,000 cu ft a day. Of this volume, 260,000,000 cu ft will be delivered to it initially by Midwestern Gas Transmission Company, also under construction. By the end of 1961 Midwestern deliveries will have increased to 360,000,000 cu ft a day.



Route of Humble's new gas line from King Ranch to Clear Lake passes under rivers, through rice fields, lowlands subject to flooding, clay and loamy soils.

CONSTRUCTION FEATURE

Varied terrain brings into play many construction techniques on

Humble's King Ranch–Clear Lake Line

Frank H. Love *Editor*

WHEN Humble Oil & Refining Company finished laying a 238-mile, 30-in. natural gas pipeline from Southwest Texas to the Houston area in September, it completed a part of a $70,000,000 gas project that was begun last year. Overall, the project includes the new 238-mile line, several gathering systems, and a gas processing and cycling plant on the King Ranch in Kleberg County. The 30-in. line will tie in with the 78-mile line completed last year from Clear Lake to the Port Arthur area.

The gas plant and part of the gathering systems remain to be finished. The plant will be far enough along to begin processing and injecting some gas into producing formations this fall, but will not be completely operative until the middle of next year. The 170-mile main gathering systems required to deliver gas to the plant are nearly complete. The gas cycling, gathering, and injection systems in the plant area, as well as facilities required in certain fields to produce and gather gas, are under construction.

Purpose of this program is to utilize gas from a number of Southwest Texas fields. The processed gas from the plant will be used for cycling and pressure maintenance in various fields and reservoirs and to supply industrial customers in the Corpus Christi, Houston, and Port Arthur-Beaumont areas.

Route of New Pipeline

The new line originates at the King Ranch gas plant, approximately 14 miles southwest of Kingsville, and extends to Humble's Clear Lake plant near Houston.

Characteristics of terrain along this route included rivers, rice fields, lowlands subject to floods, clay and loamy soils. The route leads through 11 counties, crosses 9 major rivers, passes under what will become the Victoria Barge Canal, and tunnels under 312 roads and highways. Approximately 6 miles of pipe was weighted with a heavy aggregate coating and was used in river crossings and in low marshy areas.

In the areas subject to periodic flooding, saddle weights and screw anchors were used to keep the pipe down in the ditch until the backfill had consolidated.

A greater part of the line has 4 ft of cover, as considerable cultivated land was crossed. Through rangeland and timber, 3 ft of cover was considered sufficient. These depths are in accord with the trend to more cover for pipelines now practiced by most companies.

The general contractor for the pipeline was Panama, Inc., of Houston, who put two spreads in the field. One spread started at Clear Lake, the other at the King Ranch plant working toward each other and making the tie-in on the west bank of the Lavaca River near Vanderbilt. Partner and general superintendent for the contractor was Panama Shiflett.

The north spread under the supervision of Buck McIntyre, laid 107 miles; and the south spread, with Gene Coulter in charge, 131 miles. At the peak of activity, each spread employed 200 workmen, of which 30 or 31 were welders.

The north spread began work January 19, but was plagued by excessive rainfall, losing 41 days at one period alone. The south spread got its start in February, but was more fortunate with respect to the weather. There was considerable rainfall, but much less than to the north; and soil was sandier, therefore drying out faster.

Subcontracted were the coating, performed in central yards; and stringing. H. C. Price Company of Bartlesville, Oklahoma, applied a heavy aggregate type coating to 32,000 ft of pipe at a yard set up in Vanderbilt. Coal tar enamel coating was applied by two subcontractors. Syd E. Culbertson coated the 128 miles for the north end of the system at his plant in Houston, and Rosson-Richards Company of Texas handled the coating for the south end in yards at Corpus Christi and Port Lavaca. Jess Edwards of Houston took delivery at the coating yards and strung the pipe.

Humble's district construction office, which supervised construction of the line, was established at Victoria.

Mapping the Route

Following a preliminary survey, an aerial map was made of the proposed route. From this data a construction map was drawn that showed the exact right-of-way, river crossing sites, where heavy aggregate coated pipe was to be installed, weights of pipe, changes in weight of pipe, and where road crossings were to be made.

A 50-ft permanent right-of-way was acquired with an additional 25 ft of working room, making a total of 75 ft available during construction, in most cases.

The main line is parallel to and 20 ft from an existing 14-in. line for approximately 53 miles, from Clear Lake to Pledger. From Pledger to King Ranch the pipeline was laid on a new right-of-way.

River Crossings

The nine principal rivers crossed were the Brazos, San Bernard, Colorado, Lavaca, Guadalupe, San Antonio, Mission, Aransas, and Nueces.

All pipe used for crossing rivers and marshy areas had a specific gravity of 1.4 after applying the heavy aggregate coating. Without exception, the crossings were pulled. Most of the rivers had clay beds. Exceptions were quicksand in the Nueces and Aransas.

The Lavaca, Colorado, and Brazos were dredged; ditch was made with draglines in the remainder. In most cases, pipe was buried a minimum of 10 ft below the river bed, some deeper. In each instance, sufficient backfill was provided so there was no pipe suspended, but the ditch was not entirely filled.

Four of the rivers are free stressed; the rest required sags and bends. Bends for river crossings, as well as elsewhere on the line, were made in the field. There were few prefabricated bends, and these were at road and canal crossings to stay within the right-of-way.

Between the San Antonio River and Guadalupe River, in the general vicinity of Bloomington, the area is quite often covered with water. When the Humble line was laid, however, it had dried out enough to use a conventional ditching machine to dig about 90 percent of the trench, while the remainder was dug with backhoes and draglines. Approximately 6000 ft of heavy aggregate coated pipe was shoved through this trench.

A team of sideboom tractors lowers a segment of pipe into ditch as the pipeline moves across the flat farmland of the Texas coastal plains.

At the site of the Victoria Barge Canal, an 800-ft section of heavy aggregate coated pipe was laid at proper depth. The actual width of the channel will be 150 ft.

Coating and Wrapping

At the several coating yards, No. 2 coal tar enamel was applied to a thickness of 3/32 in., after the pipe had been shot-blasted to remove rust. This was

Firing line welders put the finishing welds on pipe joints, sometimes working behind shields when the wind kicked up too much dust.

Pipe was cleaned, primed, coated and wrapped at plants in Houston, Corpus Christi, and Port Lavaca.

followed by a wrapping of 15-lb coal tar asbestos felt. Before the pipe left the yard, it was whitewashed to repel the heat of the sun and prevent softening of the coating. The type of coal tar enamel which will withstand an operating temperature of 140 F was applied to the pipe, except for approximately 15 miles of pipe used downstream from each of the four compressor stations. These sections were coated with a type of coal tar enamel to withstand a maximum temperature of 180 F.

A heavy aggregate type coating was applied on the 0.500-in. wall pipe to a thickness of 3⅝ in., giving the pipe plus coating a weight of 665 lb per ft. On the 0.406-in. wall pipe, coating thickness was 4 in., giving a total weight of 695 lb per ft.

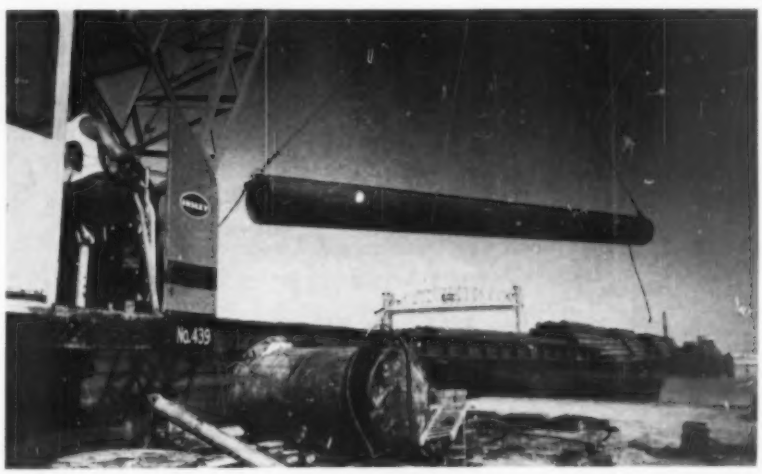
Road Crossings

Seals, insulators, casing, and vent markers were installed at all public road and railroad crossings. State highways were bored with the familiar dry type boring machine. On country roads, however, the wet method was employed.

Casings used on the line were 34 and 36-in. diameters.

Testing and Cleaning

The line was hydrostatically tested in accordance with Section 8 of the ASA B 31.1 Code. A squeegee pig was pushed ahead of the water to clean the line of dirt and displace the air. After the test was completed, the water was removed by running a squeegee pig pushed by gas. Scrapers were run to free the line completely of dirt and water. Pressures to which the pipe was subjected varied with wall thickness,



Pipe from McKeesport, Pennsylvania, and Orange, Texas, plants was barged to location.

Pipe used in river crossings and in low marshy areas was weighted with a heavy aggregate coating.

but in all instances provided an adequate margin of operating safety. The line was tested in sections, the length of each also depending on pipe wall thickness.

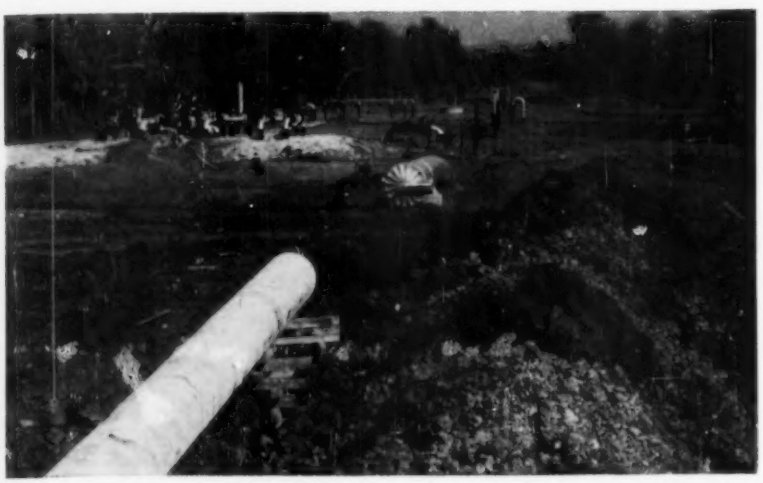
Rice Fields a Problem

One of the problems in laying the pipeline was the crossing of rice fields, of which there were many on the north section of the line. Insofar as the fields themselves were concerned, the procedure was relatively simple. Levees were thrown up on each side of the right-of-way by pushing up the dirt with bulldozers. Canals for flooding the rice fields presented a more difficult problem, however. These were bored and cased for the most part. When quicksand was encountered, and the contractor could not bore, the only solution was to wait until the irrigation ditches were not in use, then ditch by customary methods. In some instances, wellpoints were set, but only when absolutely necessary, because of the cost.

Some irrigated cotton land also was found along the route of the line, but these fields were crossed at a time when irrigation was unnecessary and the soil fairly dry.

Across the coastal plains a ditching machine of this type could make about a mile and a half of 6-ft-deep trench a day.

Texas' Gulf Coast is interwoven with pipelines. Here an electronic detector is being used to make certain a ditching machine will not cut into a buried line.



As line was laid, contractor installed manifolding, valves, and bypasses at sites of four future compressor stations.

Welding

Pipe joints were manually welded in the field; there was no double-jointing. Line-up and welding were greatly speeded by the use of air-actuated hydraulic line-up clamps.

All welds on river crossings were X-rayed. A small percent of the main line welds were spot-checked by X-ray.

Line Pipe

Line pipe was API 5LX-52 and was delivered in 40-ft joints. Most had a wall thickness of 0.406 in. for the main line, with limited amounts of 0.500 in. and 0.625 in. used. Pipe for the north end was out of Houston and Milwaukee mills. The Houston pipe was trucked to location; the Milwaukee pipe shipped by rail. Pipe installed on the south end was from mills at Orange, Texas, and McKeesport, Pennsylvania. The Orange pipe and the McKeesport pipe were barged.

Future Compressor Stations

Initially, pressure for moving gas to destination will be provided by natural well pressure and compressors in the producing fields from which gas is being taken. Sites for four future compressor stations along the line have been selected, however; and the contractor installed manifolding, valves, and bypasses for these stations at the time the line was laid. The station sites are near Robstown, Refugio, Lolita, and West Columbia. ★ ★ ★

CONSTRUCTION FEATURE

FIG. 1. Subsurface analysis starts with the strike of the hammer against a steel plate on the ground. The shock wave travels underground to the geophone and on to the electronic counter. Distance can be measured from the plate to the geophone. Time is measured by the counter.

ROCK . . . Where and How Tough?

By seismic analysis pipeliners can determine when they can rip and when they must blast

ROCK—where and how tough—has long been a headache for pipeliners.

Some important questions confront pipeliners when their big ditchers start down the right-of-way: Is there any rock in the path of the wheel? Can the rock be ripped? What equipment will be needed? How should it be used?

Proper answers to the questions can mean several days and many dollars gained — sometimes can make the difference between getting or losing a contract, profit or loss on a job.

Caterpillar Tractor Company has developed seismic analysis as a quick, easy, and inexpensive method to determine whether subsurface material is rippable without moving a tractor and ripper onto the cut. Tractor-ripper tryouts are time-consuming and costly.

Existing Methods Examined

First, engineers examined other methods to determine whether they could be adapted to this problem. The Los Angeles Rattler Test for hardness — conducted on a sample of rock — looked good at first. But hardness alone does not determine rippability. Even granite can be ripped economically if it is fractured or weathered. *Consolidation* is the key to rippability. Core drilling only tests spots, not overall conditions—and the rattler test checks only rock samples, not consolidation.

Next, the electrical earth resistivity method was considered. It has been used successfully by the Bureau of Public Roads and state highway engineers. In this method, an electrical voltage is applied across an area to measure the resistance of the earth. Good results are obtained in unconsolidated materials, but a typical state highway department believes it takes a trained geologist with a year's experience to accurately interpret the readings obtained.

Seismic Analysis the Answer

Caterpillar wanted something simpler — something a user could handle with only a few days' training. Seismic analysis offered these features. The refraction seismograph has been used extensively in mining and petroleum work. It is lightweight, sturdy, and accurate; it can be operated with a minimum of training. The procedure was available — it was only necessary to interpret the results in terms of rippability.

Principles behind seismic analysis are simple. Sound or shock waves travel through varying subsurface materials at different speeds and along separate paths. Speed of a seismic wave depends upon the type and density, or consolidation, of the material. Path of the wave varies with speed and the thickness of the layers of the material through which it passes.

A wave source will create numerous waves. At short distances the surface wave will be the first to reach the receiver, or geophone. As the distance from the source to the geophone increases, waves refracted through denser subsurface materials, traveling at a greater speed, will reach the geophone before the surface wave. Only the first wave received is recorded by the electronic time counter.

With this time and distance data, two formulas and a graph provide information on the depth of the layers of different density materials and the speed of the waves. Rippability can be determined by identification of the materials and relating the speeds of the waves to the materials.

Equipment Needed

Equipment needed for seismic analysis includes a source of a wave, a receiver, an electronic counter, and a set of tables.

The sound or shock wave can be produced by several methods. In oil field work, dynamite customarily is used. This can give readings down to more than 25,000 ft. Such depth is not

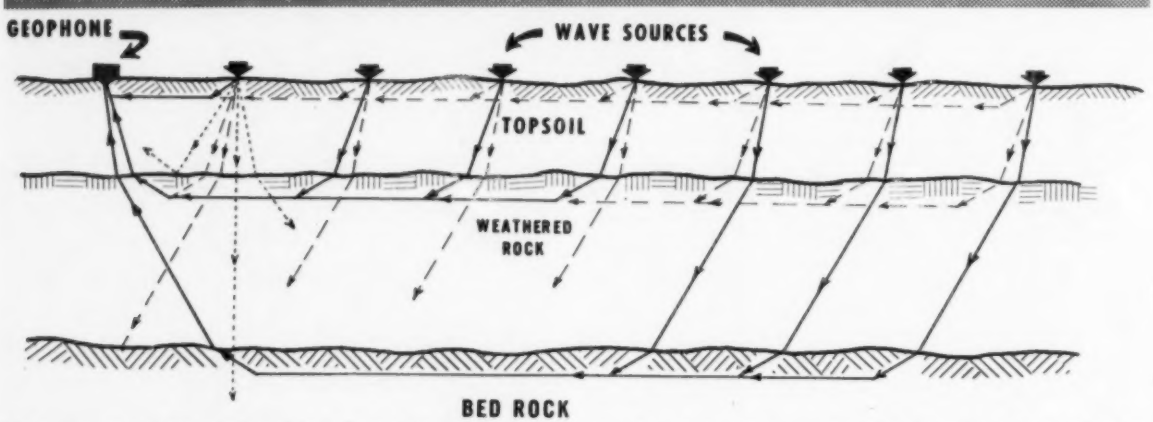


FIG. 2. Operation of the seismic analysis is illustrated in this diagram. Seismic waves are created at the arrows, starting at a point 5 ft from the geophone and moving out 5 ft at a time to 40 ft. At 5 ft the wave near the surface is the first to reach the geophone. From 10 to 20 ft the wave traveling through the denser weathered rock reaches the geophone before the waves traveling through less dense topsoil or the deeper bed rock. Beyond 20 ft the waves traveling through the bed rock are the first to reach the geophone. Although these waves travel farther, they move faster.

needed to check a ditch cut. In addition, even a small blast should not be used in many areas due to proximity of men and machines or populated areas. For the purpose of this study an 8-lb sledge striking a 6-in. by 6-in. by 1-in. thick steel plate produces an adequately sharp wave, strong enough to provide readings to depths of 50 ft.

The receiver is a standard geophone — a moving coil in a silicone fluid, resting on a base. A flat base geophone, which sets on top of the ground, is used if the surface is hard. A cone-shaped base can be pressed into the ground for better pickup in loose soils.

An electronic counter determines the time interval between the strike of the hammer and the arrival of the seismic wave at the geophone.

Rippability Based on Wave Velocity

Knowing the time of the wave travel and the distance from the hammer to the geophone, depth and wave velocity can be determined with two formulas. Caterpillar has conducted more than 200 tests in 18 states to establish tables of rippability based on wave velocities for a dozen of the more common materials. As wave velocities and rippability vary by consolidation, the table can be used to learn whether a certain velocity through a certain material indicates it is rippable.

Kansas Test

Recently, a test was run on a section of the 24-in. Michigan-Wisconsin pipeline being looped near Manhattan, Kansas. Three areas were checked where possibilities of rock were indicated by the terrain.

Two men easily carried in their 40-lb equipment. Inside a small metal case, about the size of an overnight case, was the electronic counter, ready to operate on self-contained batteries. A geophone was set on the ground and its wire plugged into a receptacle in the face of the counter. One end of a 100-ft wire was plugged into a second receptacle and the other end connected to a spring contact switch on an 8-lb

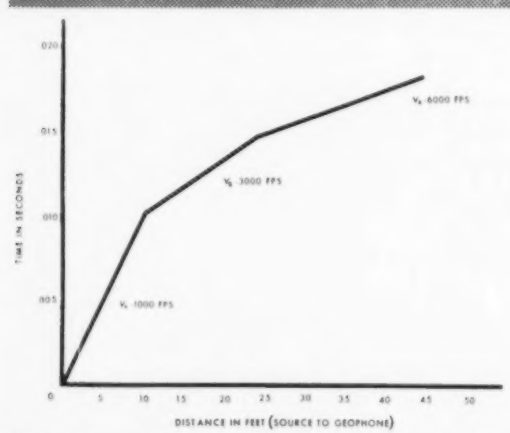


FIG. 3. Time and distance are plotted on a graph, with distance in units of feet along the bottom and time in units of milliseconds along the side. Straight lines are drawn through adjacent points. Xc (see formula in article) is the distance from zero feet to the point of intersection of the lines. Each material will have its own slope.

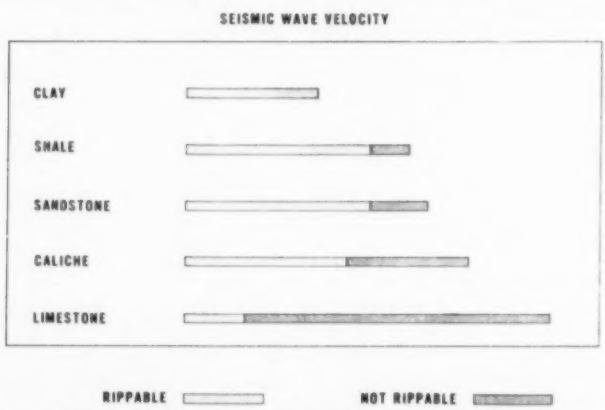


FIG. 4. To determine whether a subsurface material is rippable, Caterpillar engineers have compiled tables such as this on 12 common materials. The breakover point on wave velocity between rippable and non-rippable varies for each type of material. Separate tables must be compiled for each size ripper. This one was developed for the Caterpillar D9 tractor with mounted hydraulic No. 9 ripper.

sledge. A small steel plate was set on the ground 5 ft from the geophone.

One man took readings from the counter while the second struck the steel plate with the sledge. When the sledge struck the plate, the switch closed, starting the counter. Lights flashed across the counter, marking the milliseconds fleeting by until the seismic wave reached the geophone, stopping the counter. Steady lights indicated the elapsed time. This time was noted on a data sheet opposite the distance from plate to geophone while the hammer man moved the plate to a new location, in line with the first but 10 ft from the geophone. This process was repeated every 5 ft until the plate was 40 ft from the geophone. (See Fig. 2.)

In less than 10 min the test was completed and computations were made. Velocity of the seismic waves were found by the formula:

$$V = \frac{D}{T}$$

Where D is the distance from the plate to the geophone, and T is the time lapse.

This was plotted on a graph, with distance in feet plotted along the bottom and time in milliseconds plotted up the side. Points fall in line for each type of material as velocities are the same for a similar consolidation. Straight lines drawn through adjacent points showed three types of materials. Intersection of the lines indicated the changes in consolidation.

Next, the depth at which these changes occurred was computed from the formula:

$$D = \frac{Xc}{2} \quad \frac{V_2 - V_1}{V_2 + V_1}$$

Where D is depth; Xc is the distance along the bottom of the graph from zero to the intersection points of the lines; V_1 is the velocity of the seismic wave in the upper layer; and V_2 is the velocity of the wave in the next lower layer. Depths of successive layers are determined in a similar fashion. (See Fig. 3.)

Results indicated that topsoil extended 3.5 ft deep. Weathered rock lay below this material, resting on bed rock, 10.7 ft below the surface. Velocity of the seismic wave through the rock indicated it was rippable.

In this case, the type of rock was determined by outcroppings. It also can be determined by core drillings or local knowledge. With this information, the pipeliner would be better able to schedule his equipment needs.

Thus seismic analysis can help pipeliners determine when they can rip and when they must resort to blasting. ★

Texas Gas "Running the Gamut" of Tough Pipelining

ALL ALONG the 900-mile front of Texas Gas Transmission Corporation's pipeline system, construction crews are pushing full speed ahead toward the completion of two expansion programs totaling $60,000,000.

From the Gulf Coast up through Louisiana, Arkansas, Mississippi, Tennessee, Kentucky, Indiana, and into Ohio, eight contractors have construction crews laying new loop lines and building additional compressor facilities under two separate expansion projects.

One application, approved by the Federal Power Commission in late 1958, authorized Texas Gas to proceed with a $20,000,000 construction program designed to supply an additional 113,000,000 cu ft of gas per day to existing customers in the Big River Region.

Under this program, Texas Gas also is expanding its existing underground storage facilities at Oaktown and Alford fields in Indiana, and in the Dixie and Hickory School storage fields in Kentucky, and began operation of its Wilfred storage field in Sullivan County, Indiana.

Another application, certificated by the FPC in early August of this year, authorized the construction of facilities required to transport up to 100,000,000 cu ft of gas daily for the account of Hope Natural Gas Company, a subsidiary of the Consolidated Natural Gas System.

The Consolidated Natural Gas System supplies the steadily mounting gas requirements of more than 1000 cities and communities in the states of West Virginia, Ohio, Pennsylvania, and New York, and the interconnection of the pipeline facilities of Hope and other Consolidated affiliates will make possible the delivery of gas to these customers.

The transportation agreement through which service will be made to Hope has been referred to by W. M. Elmer, Texas Gas president, as "one of the most important market developments in the history of the company."

Building Since Early Summer

The expansion program designed to increase deliveries of gas to existing customers has been under way since early summer, and includes approximately 126 miles of pipeline up to 30-in. in diam, and the addition of 10,460 compressor hp.

Work on the facilities that will make possible the deliveries of gas to Hope began in September, and includes the first offshore lines to be laid by Texas Gas. The construction consists of 245 miles of pipeline up to 30-in. in diam, which are being laid as loop lines of varying lengths at several points on the system, and 104 miles of smaller diameter gathering and supply lines to be laid in south Louisiana, and into the Gulf of Mexico offshore from Cameron Parish, Louisiana. A total of 15,760 hp is being installed, of which 14,000 is being added at existing compressor stations and 1760 at a new station near Lafayette, Louisiana. The new station will be the farthest south of any on the company's system.

The facilities constructed under the two expansion programs will raise the year's total pipeline additions to approximately 475 miles. Of this total, 257 miles is 30-in. pipeline, 100 miles 26-in., and the remaining of smaller diameter.

Compressor engine additions at several existing stations, and the new compressor station, total 26,220 installed hp. Upon completion of the expansion programs, Texas Gas will be operating more than 4100 miles of pipelines and 25 compressor stations with 222,760 hp.

From the Gulf of Mexico, where sea-going pipeliners are laying concrete-coated pipe in a ditch scooped from the Gulf's bottom — to southern Ohio, construction spreads are "running the gamut" of tough pipelining conditions.

Through Varied Terrain

Pipe is being laid in marshland and swamps that only stubbornly yield to penetration . . . across fertile fields where rice, sugar cane, cotton, corn, and tobacco recently have been harvested . . . through rocky hill country and pine forests . . . and across the Green River in Kentucky, where a 26-in. submarine pipeline is being laid.

Gas supplies required to increase deliveries to Texas Gas's existing customers are being obtained from the company's supply sources in south Louisiana, and a portion of the gas to be gathered and transported for Hope is owned by Hope, and the remainder of the gas is to be bought by Hope directly from producers in south Louisiana.

In their race against time and the weather, construction crews are working seven days a week in their efforts to make it possible for Texas Gas to start deliveries of gas to its customers and to begin its transportation of gas for Hope Natural Gas Company sometime early in December. ★ ★ ★

Underground Corrosion and Methods of Control

PART I

O. C. Mudd, *Consulting Engineer, Alpine, Texas*

INTRODUCTION

Structures associated with our present civilization are subjected to various natural forces of destruction, some of a violent, spectacular nature, whereas others continue their deterioration over long periods of time, unnoticed until impairment or failure occurs.

Deterioration signs on above ground structures are usually detected by visual inspection, but those buried below ground or included in structures where access is difficult or impractical may entail prohibitive costs in attempting inspection. Hence, it is essential that adequate measures be included in design of such inaccessible structures, or their components, to minimize impairment and failure.

Underground structure impairment or failure predominately occurs from external soil corrosion when adequate preventive measures are not applied.

Metallic corrosion is oxidation. A burning structure is also oxidation and this rapid destruction attracts attention, but too often slow oxidation, such as corrosion, is passively tolerated, yet the end results are the same. Hence, in the interest of good economy corrosion prevention is as essential as fire prevention and even more so for underground structures where oxidation often proceeds undetected until failure occurs.

THEORY OF CORROSION

Metals are derived from natural ores by heating and the amount of heat necessary to reduce any specific type of ore to its metal is known for those metals in common use. The amount of heat necessary to reduce metals from their ores varies with the metal and those requiring greater amounts are usually more susceptible to corrosion.

This same amount of heat is liberated from the metal when reoxidized to its original form as an ore, however, this liberated heat varies with each different oxidizing agent attacking a specific metal.

Metals differ from each other by their electrical relation when immersed in chemical solutions and this relation, under stipulated conditions, constitutes the "electromotive series" (EMF) of metals. This series is established by measuring between a hydrogen reference electrode, as an arbitrary zero potential, and the immersed metal; each metal then being either positive or negative to this reference electrode.

An abbreviated electromotive series table follows, and included are the heats of formation for each of these metals from its chloride solution.

Metal	Potential to hydrogen	Heat of formation K. Cal/G
Gold (Auric)	— 1.36	(31.4)
Platinum	— 0.86	(35.8)
Copper (Cupric)	— 0.34	(62.6)
Hydrogen	0.00	
Lead (ous)	+ 0.12	(79.11)
Nickel	+ 0.23	(94.2)
Cadmium	+ 0.40	(96.08)
Iron (Ferrous)	+ 0.44	(99.7)
Chromium (ous)	+ 0.55	(118.3)
Zinc	+ 0.76	(115.2)
Manganese	+ 1.10	(128.6)
Aluminum	+ 1.70	(163.2)
Magnesium	+ 2.40	(189.1)

These potentials are determined in dilute solutions containing only a compound or salt of the metal measured, and these potentials will be subject to variations when salts of differing metals are used.

In general any metal higher or more noble in the EMF series, i.e., gold, platinum, etc., is less likely to corrode than those lower in the table, and any two different metals connected in a chemical solution normally results in the oxidation or corrosion of the less noble metal whereas the more noble suffers little or no oxidation.

The heats of formation are also indicative of this same order of oxidation susceptibility. It is apparent from the heats of formation that metals requiring greater amounts of heat to effect reduction have greater potential energy, fostering easy oxidation.

ELECTROCHEMICAL CELLS

An electrochemical cell must have no less than two electrodes immersed in an electrolyte with an external electrical conducting circuit connecting between the anodic and cathodic electrodes (Fig. 1).

The "electrolyte" normally is composed of chemicals dissolved in water where the chemicals segregate into components called "ions," which are capable of transporting electrical charges, and this ionization is a requisite in establishing an electrolyte. It may be homogeneous where chemical diffusion is not restricted or it may vary in composition and concentration where diffusion is restricted, as in moist soil.

The "anode" is a metal, or other electrical conductive substance, where current flow leaves the surface to the

electrolyte. This surface is oxidized or corroded. Atoms leaving the surface lose electrons and become charged "ions" in the electrolyte, and these are known as anions.

The "cathode" is a metal, or conducting material, which receives current flow to its surface from the electrolyte and the charged atoms, or anions, lose their charge as they are deposited or "reduced" at the cathode surface. Cations from the cathode transport equivalent opposite charges to the anode surface.

These anions departing from the anode may be changed from their original composition during passage through the electrolyte and a different type of atom will then be deposited on the cathode. Iron atoms leaving an anode, as ions, may be changed to an insoluble oxide by oxygen ions in the electrolyte, and hydrogen ions are then available in transporting the original iron ion charges to the cathode surface, thus depositing hydrogen.

The charges deposited on the cathode surfaces, in combination with electron liberation at the anode, cause current flow through the exterior circuit, thus completing a circuit. In brief, then, current flow through the electrolyte is from anode to cathode, and through the electrode connecting from cathode to anode.

Electrochemical cells may be of two types:

1. Electrolytic, where the energy causing current flow is from a direct current generating source external to the cell with its positive polarity terminal connected to the anode and the negative one to the cathode (Fig. 2).

2. Galvanic, where the energy source is within the cell, originating from the anode surface oxidation (Fig. 3).

Electrolytic cells are most common where industry produces metal by electrolytic processes, or where electroplating is done. However, electrolytic cells can occur underground where metallic structures lay in the path of current flow through the soil, known as stray current, from electrical generating equipment that has both terminals connected to the ground. Such connections may be intended, incidental, or accidental.

Alternating current produces little or no change on electrodes in an electrolyte because the electrodes change polarity with each cycle.

Galvanic cells are those including differences of metal components that cause current flow through the external connecting conductor between cathode and anode, and the energy sustaining current flow originates from chemical changes involving the anode and the electrolyte. These changes utilize the heats of formation to supply energy.

In a galvanic cell any metal more noble in the EMF series, such as copper, will be the cathode to any metal less noble, viz., iron, the latter becoming the anode, which corrodes when the electrolyte is a homogeneous ionized solution capable of oxidizing the anode metal.

Concentration cells are a form of galvanic cell, usually having both electrodes of the same metal, in which the energy originates from the difference in solution concentration, and the anode will be in the concentrate solution when metallic ion of the electrolyte chemical is lower in the EMF series than the electrode metal. When the metallic salt is higher in the EMF series then the anode will be in the dilute solution.

Concentration cells may formed by differences of chemicals in contact with cell electrodes of the same metal and the anode is most likely to be in the chemical having the higher heat available to initiate and continue oxidation. Galvanic cells may include any combination of the above sources of energy.

In any electrochemical cell chemical changes occur at the electrode surfaces and these changes may impede current flow.

In electrolytic cells operated for metal production or electroplating these changes can be compensated by increasing the voltage across the cell or by variations in the electrolyte.

Electrolytic cell electrodes established on the surfaces of underground structures by stray current from high voltage generators, such as used for electric railways, are usually of such extensive area and have sufficient voltage gradient imposed that electrode surface chemical changes have little effect in impeding current flow. As voltage gradi-

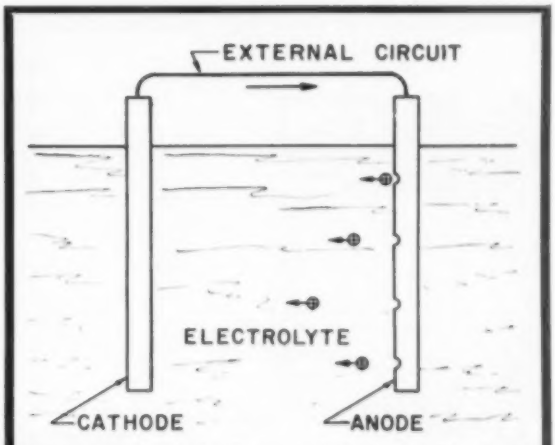


FIG. 1. Electrochemical cell composed of two electrodes (anode and cathode) immersed in an electrolyte with current flow in the external connecting circuit.

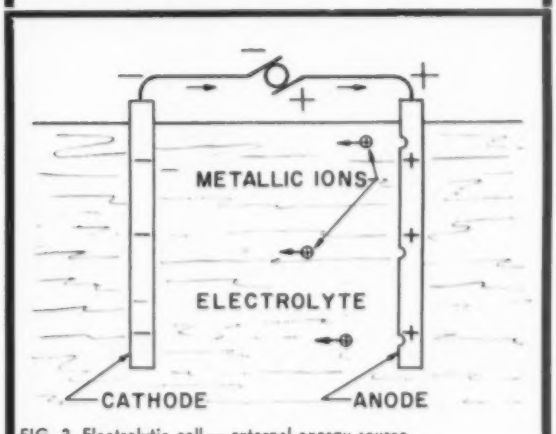


FIG. 2. Electrolytic cell — external energy source.

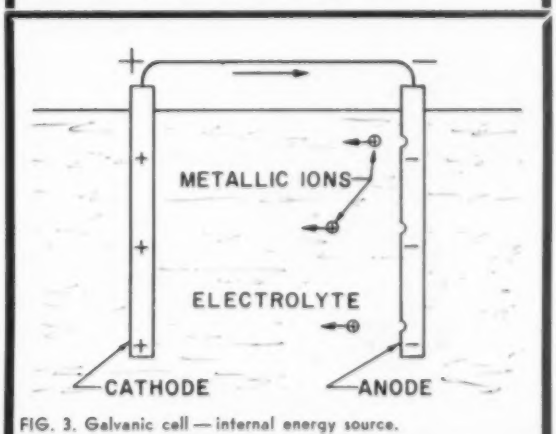


FIG. 3. Galvanic cell — internal energy source.

Honeywell Bellows Flow Meter

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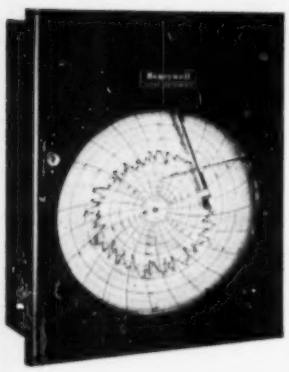
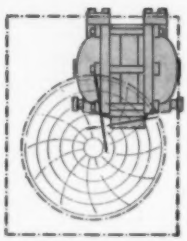
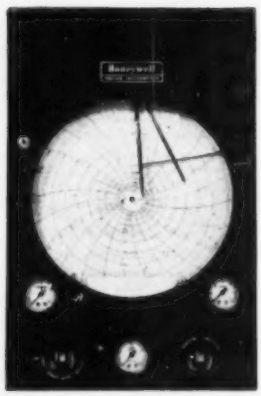


For direct measurement and control

the meter is integrally mounted on indicators, indicating controllers, recorders, or recording controllers.



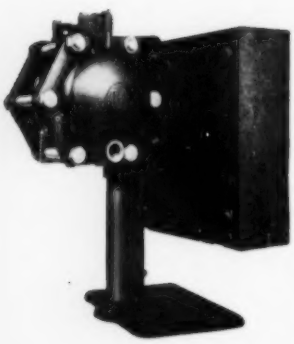


With an indicator or recorder—Indicators can be supplied with or without pneumatic transmission. Recorders can be one, two or three-pen instruments, with the second and third pens actuated by thermometer and/or pressure elements.

With a "blind" transmitter—the non-indicating differential pressure transmitter is used when indication is not required at the process and the variable is to be transmitted to remotely located in truments.

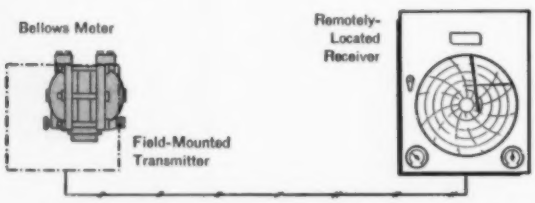
With indicating or recording controllers—All indicators and recorders can be supplied with any pneumatic control form from on-off to three-mode. Indicating controllers are also available with pneumatic transmission.

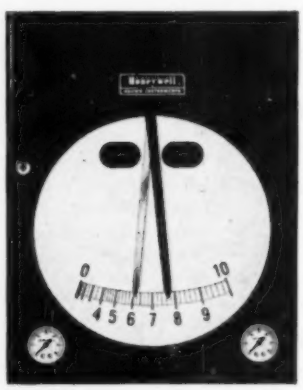
With an indicating transmitter—Scale is graduated in accordance with the flow or liquid level span of the transmitter. These transmitters are available with pneumatic control to remotely operate final control elements.



For remote measurement and control

Field-mounted transmitters, either "blind" or indicating, can be used with remotely located indicators, recorders, and controllers.





and with Tel-O-Set miniature instruments and a variety of options!

has applications unlimited

Unequaled for accuracy, stability, versatility in flow and liquid level metering

Here's the most advanced meter body available today, with advantages never before found in flow and liquid level meters. Combine the new Honeywell Bellows Flow Meter with the instruments shown on the facing page for truly superior service in metering steam, water, gas, oil and other fluids.

Some of its outstanding features:

Sensitive and accurate—Sensitive to within 0.05% of full scale . . . calibrated accuracy ±0.5% of full scale.

Leakproof—Between liquid fill and process fluid.

Automatically stabilized—Changes in meter body temperature or static pressure have no effect on output shaft position. Meter operates efficiently in ambient temperatures of minus 40°F to plus 250°F.

Unmatched convenience features—Including fast range changing in the field . . . connections for both horizontal and vertical piping . . . quick calibration and adjustment . . . easy cleaning and servicing.

High corrosion resistance—Seamless, tainless steel formed bellows give long, trouble-free service with virtually all process fluids.

Fast, effective damping adjustment—New type pulsation check with rectangular orifice permits essentially linear damping adjustment . . . and adjustment from outside the meter body during operation.

Models are available in many ranges, for both flow and liquid level measurement and control. Get details on *all* the features of the new Honeywell Bellows Flow Meter by calling your nearby Honeywell field engineer today . . . he's as near as your phone.

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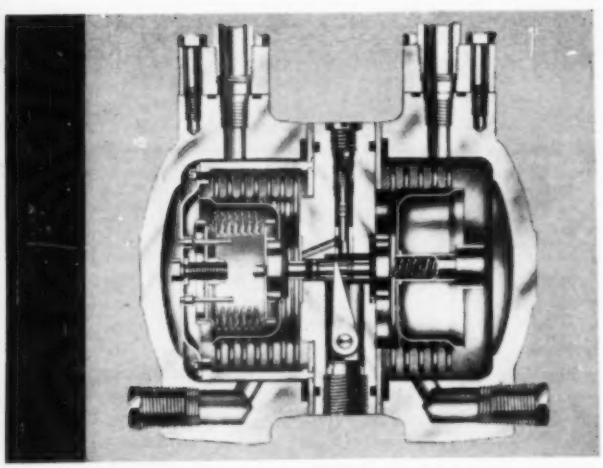


Transfer of liquid between opposing high and low-pressure bellows converts differential pressure measurement into motion. A torque tube assembly carries the motion outside the meter body to an instrument. Therefore, changes in differential pressure change the instrument reading.

Honeywell

H HONEYWELL *First in Control*

ents decrease, electrode surface changes have more effect on current flow.

Galvanic cells with relatively low voltages are more subject to variations in current flow by chemical changes at the electrode surfaces. Such cells having small cathode areas usually curtail anode losses and large cathode areas usually accelerate anode losses.

In some cells the metallic ion leaving the anode surface may be converted to an insoluble compound and thus form a barrier, impeding current flow. Iron oxidized to ferrous or ferric oxide is an illustration.

In most cells the cathode surface undergoes a change by hydrogen deposition and when the entire surface is covered the cell is then termed as "polarized," which impedes current flow.

This polarization effect is the basis of "cathodic protection." The voltage of most galvanic cells is not high enough to cause sufficient current flow through the hydrogen film to liberate additional hydrogen.

If the voltage, as in electrolytic cells, is high enough to sustain current flow through this hydrogen film the additional hydrogen gas is liberated from the cathode surface and small bubbles rise to the surface of the electrolyte. Such would be the case if excessive current flow was applied with cathodic protection along a submerged pipeline, and this gas liberated at the surface above the cathode indicates waste.

PIPELINE CORROSION

Underground pipeline corrosion occurs predominately from galvanic cells originating from metal or chemical differences (Fig. 4).

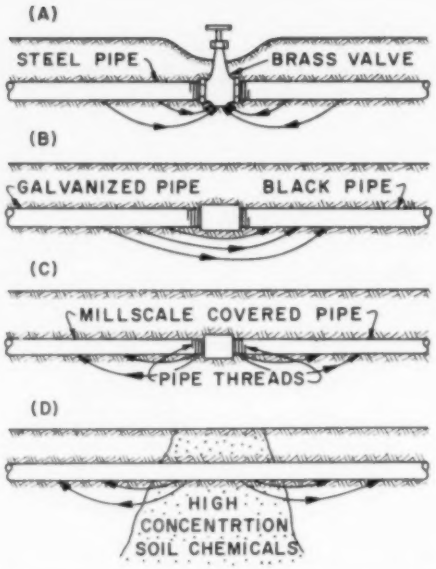
Metal differences occur when different types of materials are assembled into a buried line, such as brass or bronze valves, cast-iron or steel fittings. Mill scale on pipe has an electrical difference from that of the metal under it and the difference is often noticeable when bare threaded pipe is placed underground. The exposed threads often corrode, thus demonstrating that the adjacent mill scale serves as a cathode.

Galvanizing an iron pipe acts as the anode in a galvanic cell, thus giving some degree of protection to any exposed iron until the zinc is consumed or becomes passive by anode barrier formations.

Old rusty pipe becomes the cathode when connected to new pipe, thus causing rapid deterioration of the new while the old may continue in service.

Bends or dents in pipe cause a difference in the metal that makes these strained portions more susceptible to corrosion, and metal under tension is more likely to corrode than that under compression.

O. C. Mudd *was retired from Shell in 1955 after 25 years service and now resides at Alpine, Texas, doing occasional consulting work. Back in 1933 he was transferred from Shell's Wood River, Illinois, refinery to Shell Pipe Line Corporation. His duties were to assist in the first organized corrosion investigation on Shell's pipeline system. He has followed this field ever since and has pioneered many advancements and advised on corrosion problems in many parts of the world. He was born in Butte, Montana, and studied electrical engineering at Montana State College until 1917 when he entered military service. After the war he joined Montana Power Company and was assigned to various duties in operation and construction. In 1925 he was superintendent of construction for a contracting firm and in 1928 he joined Shell.*



CELL	TYPE	CAUSED BY DIFFERENCE OF:	ANODE	CATHODE
A	GALVANIC	METALS	LARGE	SMALL
B	GALVANIC	METALS	LARGE	LARGE
C	GALVANIC	METAL SURFACE	SMALL	LARGE
D	CONCENT.	CHEM. CONCENT.	SMALL	LARGE

FIG. 4. Electrochemical cell types in soil.

Most of the high alloy steels act as a cathode to low alloy steels.

In all of the above no corrosion occurs unless an electrolyte provides a path between anode and cathodic surfaces to establish galvanic cells. This electrolyte also can accelerate the corrosion rate when concentration cell action contributes toward increasing the cell current flow.

Concentration cells are established where concentrations of soluble chemicals, including oxygen, vary along the metal pipe laid in contact with the soil, and extremes of variation may occur within a few feet or may be gradual over several hundred feet or more. Also, variations, particularly oxygen, often occur between top and bottom of the pipe, resulting in severe corrosion along the bottom where oxygen is absent or low in concentration, thus preventing a protective oxide film forming over the corroding surface. The bottom of the trench also may harbor a higher concentration of soil chemicals, thus contributing to an increased corrosion rate.

Some of the most severe corrosion along pipelines, remote from stray currents, has been found where oxygen was excluded and the soil contacting the pipe contained crystals of soluble chemicals of natural origin or from industrial waste contamination.

Pipe buried deep in flowing stream banks often suffers rapid corrosion from concentration cells where the seep water in the banks contains more chemicals than the flowing stream water, and in some cases pipe in the stream suffers when the stream water has the higher concentration. In the latter case most severe attack is near the stream edge, nearest the cathode area established in adjacent higher ground.

(To be continued in an early issue)

USE OF COMPUTERS IN SCHEDULING FOR PRODUCTS PIPELINES

High speed data processing equipment aids the efficient and accurate control of tenders

C. A. Stapleton, *Design Engineer, Plantation Pipe Line Company*

PROBABLY THE MOST TEDIOUS and time-consuming operation of the modern products pipeline dispatcher is the attempt, shall we say, of trying to determine what is going on at the present time with respect to pipeline operations and what will be going on in the immediate future.

While it is conceivable that the dispatching of a single tube pipeline with relatively few batches and terminals is a relatively simple operation, installation of additional parallel lines, with consequently more batches and more terminal points, presents almost insurmountable problems and results in undue hardship on the dispatcher and increases the chances of costly mistakes. It is because of this latter condition that computers are being used as an aid to the modern pipeline dispatcher.

How a Modern System Operates

In order to more fully appreciate the value of the computer in dispatching work, it may be well to describe briefly some of the operations of the modern products pipeline. For illustration we will consider the Plantation Pipe Line Company system.

At the originating or source point of a pipeline, various tanks are required, number and size of which will depend on the number of different products handled, size of the tenders, and rate of turnover. These tanks are used to hold the different products in readiness for pumping into the pipeline as they may be scheduled.

Usually the scheduler of the pipeline, working in close collaboration with various shippers of products, will determine quantity and time of arrival of products at the source point. This is necessary so that the pipeline rate may be established properly and to insure that batches of products arrive essentially in the order in which they will be pumped to the pipelines.

Batching in "cycles." To reduce commingling between batches of different characteristics, products of essentially the same order are usually pumped together, that is, one batch following the other in a "cycle." For instance, a cycle may consist of several different grades of gasolines, or it may consist essentially of fuels where very slight commingling at the interface will not be particularly detrimental to either. It is important to bear in mind that the order of cycles pumped to the pipeline are strictly regulated.

It is necessary that enough batches of gasoline to make up a cycle be at the source point, or close thereto, before the gasoline cycle is started pumping to the pipeline. Before the gasoline cycle is completed, sufficient batches of fuels or other like products must be ready at the source point so that the pipeline may continue pumping without interruption once it is started. Cycles follow one another in sequence and this procedure is repeated day in and day out on a 24-hr basis. This seems a fairly simple process, but it is only one of many phases of the dispatching operation.

Scheduling made far in advance. Before each batch of each product for each shipper is pumped into the pipeline, it must be determined where each batch or part of a batch is to be delivered out of the pipeline to the shipper's terminal tanks.

For continued smooth operation of the pipeline, the above scheduling must be done considerably in advance and it is usually based on estimates of quantities and dates of actual pumpings. Estimates of throughputs normally will be studied as much as a year in advance and actual schedules prepared as much as 45 days in advance. Naturally, these estimates and schedules will be subject to considerable change before and after the products are actually pumped to the system.

To the casual observer this procedure may seem somewhat haphazard, but a more logical approach to the problem has yet to be conceived. The whole process of scheduling and dispatching is continually subject to change, due to changes in demand for certain products, throughout the pipeline system.

Batches are continually tracked. At the time products are pumped into the pipeline, they are by no means forgotten but are continually tracked until finally delivered out of the system. On one particular pipeline, each batch may be only one of some 98 batches throughout the system, and it may be scheduled to be delivered all to one or partially to some of the 102 terminals located at 19 points on the system. It may even be destined to be broken out of the trunk line system for delivery in whole or in part to two separate tank farms and thence pumped to any one of five lateral pipelines.

The pipeline normally takes custody of all products for pumpings upon delivery to its source point tanks. Delivery to source point, which is the shipper's responsibility, may be by barge, tanker, or pipeline. Measurement of tenders may be by tank gage or by accurately calibrated meters. Once the custody transfer has been made, the pipeline is responsible for the product until its final delivery to the shipper's terminal.

Measurement of deliveries may be by meters or tank gages, as the pipeline tariff may specify. Accuracy of

Presented before American Society of Mechanical Engineers, Petroleum Mechanical Conference, Houston, Texas, September 20-23, 1959.

measurement is most essential not only from the standpoint of accountability for products, but for its use as an aid to determine whether leaks exist in the pipeline.

Each batch is given a code number. As each batch of product is moved from the source point into the pipeline, it is filtered, metered, and identified by a code number. Its quantity in barrels as well as its physical characteristics are noted and samples taken for possible future reference. Average temperature and the pressure is also recorded for correcting the existing volume to a 60 degree F basis.

As products arrive at terminal points for which they are scheduled, they are filtered and metered through accurately calibrated meters and delivered into the shipper's tanks.

Use of "stream sheets." At hourly intervals the above information from the source points and terminals is transmitted to the dispatching office, usually by teletype. In this office the information is transferred to "stream sheets." These stream sheets are a series of elongated strips of paper approximately 4 in. to 6 in. wide glued end-to-end, the length of each sheet representing a batch being proportional to the number of barrels in the batch. One edge of the stream sheet is marked by a series of graduations, each of which represents a certain number of barrels of product in the pipeline.

By laying the stream sheets out on an elongated table, or "dispatching board," on which are shown to scale the location of all pumping stations, terminals, block valves, rivers, and other pertinent data, dispatchers can determine readily the exact location of each batch of product in the pipeline. As parts of batches are delivered out of the pipeline, the stream sheet is shortened by the amount of product delivered.

With the above information, and knowing the pumping rate from the source point, the dispatcher can advise each pumping station and terminal of the expected arrival of each batch. This advance information allows each location on the pipeline to line up its operations for pumping and deliveries.

Also located in the dispatching office there may be miniature colored lights for each location on the pipeline, which indicate how many pumps are running at each pumping station and where deliveries are in progress. One or a series of teletype circuits may be used with all stations and terminals and the dispatching office on one circuit for one or more pipelines.

The foregoing touches only the highlights of a single tube pipeline, and addition of parallel lines not only multiplies the data the dispatcher must record, but also multiplies the troubles he encounters when simultaneous operations occur such as shutdowns of pumping units due to power failure, changes in pumping or delivery schedules, or any other changes that may alter the proposed schedule.

How the Computer Is Used

Suppose we now look into the use of a computer to take some of the routine work off the dispatcher. It may well be that in the first use of the computer, it will merely serve as a checking instrument on the accuracy of the dispatcher, but as its reliability is proved and its acceptance becomes a fact, it can be quite effective in relieving some of the stress of dispatching and scheduling work.

The computer to which we will be referring is a magnetic drum data processing machine with its accompanying read-punch and power units. Associated equipment with the above include:

1. Teletypewriters for each circuit,
2. Tape reperforators,
3. Tape-card punch machine,
4. Tabulating machine,
5. Card-tape punch machine,
6. Transmitters.

A brief description and the functions of each of these pieces of equipment will follow.

The operations of a computer are so highly complex that a detailed description here will not be attempted, but the sequence of operations as to how the information it provides is used will be briefly detailed.

For illustration, let us assume that the pipeline is in operation, that batches are being pumped from the source point into the pipeline, and normal deliveries are taking place at various terminals. The pipeline scheduler prepares a daily pumping order for several days in advance. This order will show estimated time and date to pump each batch to the pipeline. It will also show batch number, pumping rate, tank from which the product is to be pumped, as well as the amount in barrels to be pumped. Other special instructions may be included, such as when to inject a dye plug between batches and when to run a scraper. This latter information is for the pumping station. The order also will include for each terminal the estimated time and date for each delivery of each batch, including its take-off rate and quantity to be delivered.

Preparing the program. Preparation of the pumping order is the start of a series of operations necessary for the smooth operation of the pipeline. Now the computer and its associated equipment begins to play its part. For it to function it must be instructed as to what it is to do. Its capabilities and speed of rapidly performing calculations are almost beyond belief, but it can perform its operation only in accordance with a particular predetermined program.

Initially the control panel of the read-punch unit must be so wired as to detail the sequence of operations. Then program information, fed into the read-punch unit by means of selectively punched cards, stores this information in the computer for future reference. Approximately 400 of these cards, which contain some 1600 program steps, are used to store the information for a particular program.

Calculations read out on punched cards. With the program stored within the computer, we are now ready by means of a series of six types of punched cards to have the computer make certain calculations and read out the results of these calculations on a series of punched cards. These cards will contain certain information regarding the future operation of the pipeline for, let us say, a period of 18 hours. Information contained on these six types of cards is:

Series 1 cards are called "line fill" cards and show the line fill in barrels between stations and terminals as well as the total pipeline line fill, all at 60 F. They also show the average line temperature and a factor for compensating for pressure.

Series 2 cards indicate the line fill by batch and the barrels per batch in sequence as well as scheduled pumpings.

Series 3 cards, known as "actual pumping" cards, show the batches pumped to the line for a certain period, temperatures of the products, gravities, tanks from which batches are pumped, and the total of each particular batch pumped as of a certain time. Information for these cards is obtained from the source point station.

"Scheduled deliveries" cards are the Series 4 cards and indicate by terminals the quantity of each batch to be delivered and its particular delivery rate. The batch code number determines the shipper to which the batch is to be delivered.

Series 5 cards indicate "actual deliveries" made by each terminal for a certain time period. These also show the total barrels delivered out of each batch and indicate temperature and gravity of the product.

Last of the six series of cards is called the "rate card" and indicates the source point pumping rate for a certain period of time. The number of rate cards will depend on the number of rate changes during the time interval under consideration.

Results tabulated on continuous

strip. After these series of six cards have been "read," the computer makes all necessary calculations and provides results as shown by another series of punched cards. These latter cards are then sent to a tabulating machine where results of the calculations are printed out on a continuous strip of tabulating paper. This tabulating paper has been preprinted in columnar form, and after the above tabulator printing it will show information under the following 16 columns.

1. Pipeline identification number, such as 18 in., 14 in., etc.
2. Pump station or terminal name,
3. Batch identification number,
4. Barrels of each batch of product in the line,
5. Barrels distance out from the station or terminal of each batch in column 3,
6. Time of arrival of each batch in column 3 at location shown in column 2,
7. Date of arrival of each batch,
8. Total amount of product in barrels to be delivered at each terminal,
9. Balance of product in barrels to be delivered out of each batch at each terminal,
10. Delivery rate in barrels per hr,
11. Time of start of delivery,
12. Date of start of delivery,
13. Time of finish of delivery,
14. Date of finish of delivery,
15. API gravity of batches of products,
16. Special information such as whether a dye plug is on head end of a batch, or if a scraper is within the batch.

Operations forecast transmitted by teletype. This tabulated data thus presents a "forecast" sheet of pipeline operations for the next 18 hours of operation. This forecast is then spot-checked by the dispatcher and sent to all stations and terminals by teletype. They are sent out daily at 4 a.m., 12 noon, and 8 p.m. for an 18-hr period.

The information is transmitted in the following manner. The punched cards that were fed into the tabulating machine for printing out the forecast are fed into a card-tape punch machine, which resolves the information contained on the cards, to a continuous 5-channel punched tape. This tape is then placed in the transmitter, which is connected to all teletypes at all stations and terminals and prints out for all locations concerned the exact information in columnar form as is shown on the forecast sheet. Special instructions, which are not practical to be shown by the data processing equipment and are in the form of a general summary of facilities to be operated, are usually added by the dispatcher at the end of the operations forecast.

At this time all locations, including the dispatcher, have a detailed setup of the pipeline operations for the next 18-hr period. Now, with this forecast as outlined, the dispatcher's work load is considerably reduced. Any number of events may occur to alter or require the preparation of a completely new forecast, but with the pattern already established, required modification is accomplished quickly and simply. We have found from experience that barring complete disruption of operations due to various reasons, actual operations follow the forecast very closely.

Updating the stream sheet. We mentioned previously that each station and terminal reported hourly to the dispatcher certain information that was required to update the stream sheets in the dispatching office. This operation is referred to as batch tracking.

Since introduction of data processing equipment, it has been necessary to report only on the even hours, thereby greatly reducing the load on teletype circuits. Information sent in on these 2-hr intervals by all locations is that referred to previously as shown on "actual pumpings" and "actual deliveries" cards. Information received comes in on a punched tape through a tape reperforating machine. This is the same as the 5-channel tape used for sending out the forecast sheet. From this tape new Series 3 and Series 5 cards are punched by the tape-card punch machine every 2 hours. The difference between the totals of these two types of cards, of course, is the "overage" or "shortage" of the pipeline for the 2-hr reporting period. At 8 a.m. each day, these cards are reconciled for the previous 24 hours to indicate the daily "overage" or "shortage."

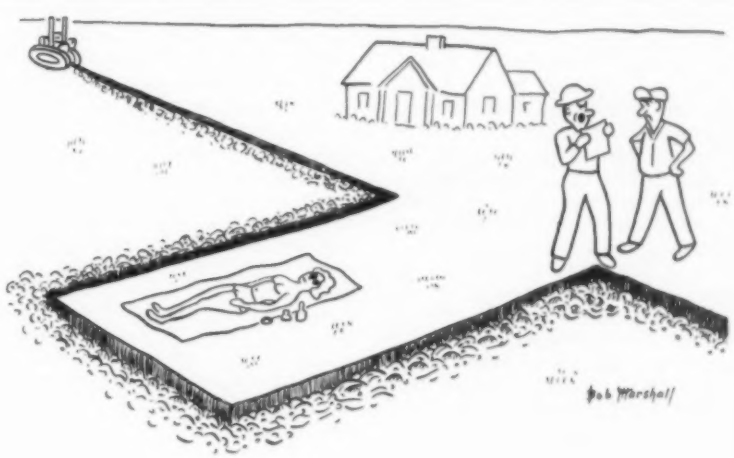
From these operating schedule reports, as the 2-hr station reports are called, the dispatcher can update his stream sheets and see how actual operations are conforming to the forecast. If there appears to be too much discrepancy between the above two, an updated or new forecast may be run in between the regularly scheduled forecasts. This will be an infrequent occurrence, however, as any progressive discrepancy would probably indicate a leak in the system somewhere.

It is conceivable that, whereas stream sheets are presently used for checking the forecasts and schedule of operations, the stream sheets may be eliminated in the future.

Forecasting period can be extended. Refinements to the above procedures are constantly being made and, consequently, more data being sent to the dispatcher from time to time. We have mentioned that 18 hours of forecasting is presently being made, but there is no reason why this forecast could not be extended to several days or weeks if such a procedure would be desirable.

There are several other applications of computers to pipeline operations in addition to the above that are under study, and it is felt that a much closer and more accurate control of operations will result from these studies.

High speed data processing equipment is a definite aid to accurate control of pipeline operations, and though quite expensive to use, its cost can only be justified after a careful survey. ★ ★



"WHO SURVEYED THIS RIGHT-OF-WAY?"

Dredging was a 24-hr a day operation in laying the 3100 ft of 12-in. line for Great Lakes Pipe Line Company across the Mississippi River between Princeton, Iowa, and Cordova, Illinois. Near the bank the line was buried to a depth of more than 30 ft.

Great Lakes Adjusts to Changing Delivery Patterns

Present construction program is one more of series in progress almost since system was first built to enable shippers to solidify their position in marketing areas

ALTHOUGH the current Great Lakes Pipe Line Company expansion contains little new in the way of construction techniques or materials used, the program is of interest because it points up the continuing adjustment and economic improvement of terminal delivery patterns in the territory served by this pioneer products carrier. At present several of the projects in the $10,000,000 expansion are completed, others virtually so, and the company is studying still others.

A brief review of the past is helpful in bringing present events into sharper focus. When the Doniphan, Nebraska, terminal was completed in 1954 Great Lakes shippers could make consignments through the system to 16 terminals, all company owned except East St. Louis. Products destined for this terminal were moved by Great Lakes to Paola, Kansas, and then transported through the Phillips pipeline.

Just a little more than five years later, with terminals scheduled in the present program at Marshall, Minnesota, and Olathe, Kansas, and through a connection with Kaneb Pipe Line to its terminals at Norfolk, Nebraska, and Yankton, South Dakota. Great Lakes shippers will be able to reach nearly double the number of delivery points that were available in 1954. Terminals added in the intervening years represent facilities built by shippers, those available by connections with other pipelines, an Air Force base, and two privately owned facilities operated under lease for the federal government as strategic storage for aviation fuels, all connected to Great Lakes lines.

Wider Range Products

What has brought about this recent rapid increase in the number of delivery outlets? Several factors are responsible, one of them being the acceptance of a wider range of products for transportation. The addition of aviation fuels — jet, and commercial and aviation avgas, can be credited directly for the connection of the air base and two auxiliary fuel storage facilities — but the dominant purpose has been to enable shippers to solidify their economic positions in concentrated marketing areas, and thus develop further business.

In the transportation concept of a system such as Great Lakes the overall movement divides into two distinct segments: The large volume movement, from refinery to terminal, and the smaller volume movement, from terminal to bulk plants and service stations.

Because the pipeline haul is the cheaper of the two, the obvious goal is to establish a system where the pipeline movement is as long as possible and the more expensive delivery hauls are as short as possible.

This was achieved in 1930-31, when the company began operation and transported gasoline solely, by locating terminals at six of the larger cities on the system.

By the end of World War II the situation had changed drastically. Great Lakes was now a multi-products carrier, terminal deliveries were preponderantly by motor transport, and with farming having become mechanized rural areas were heavy petroleum consumers.

To meet this new need Great Lakes extended its system to the northwest with a line from Kansas City to Grand Forks, North Dakota. Intermediate terminals were spaced approximately 100 miles apart and new terminals were added to give similar spacing on the older part of the system. This had the effect of increasing the distance of pipeline movements and shortening delivery hauls.

In the following years the explosive growth in demand for petroleum products kept the carrier busy increasing line and terminal capacities on an almost annual basis. When capacity and demand figures were fairly well equated another look was taken to see how transportation could be improved further. It was found that in certain areas particular shippers would benefit by having terminals closer to concentrated markets. Because these terminals would serve a smaller territory they need not be so large as others on the system. Shippers built several of the smaller terminals. At two points the company built line extensions to serve the terminals, at another it built to nearby river terminals, and two terminals

were reached through connection with another pipeline. This was the status at the beginning of the current expansion which continues the preceding evolutionary process.

The New Program

The largest single expenditure in the $10,000,000 program was allocated for construction of a 12-in. line to connect with the existing lines at Iowa City, Iowa, and Middlebury Junction, Illinois. This gives Great Lakes a 12-in. line the entire distance between Des Moines and Chicago, parallel to a 6-in., plus an 8-in. from Des Moines to Middlebury Junction. Power for the new line is supplied at Iowa City by an outdoor 1250-hp electric unit.

Line construction follows by about a year and a half modernization and expansion of the Chicago terminal.

Chicago, of course, is a highly competitive oil market served by several local refineries, by barges, and other pipelines, but the demand is so large that each terminal in the metropolitan area has its own definable territory. In recent years inadequate line capacity has prevented Great Lakes from serving its potential demand.

New Terminal at Marshall

The new terminal at Marshall, Minnesota, takes advantage of nine existing tanks and a previously constructed transport drive. Marshall was proposed as a terminal in 1945, and these facilities already had been built when it was decided that the 1945-47 construction funds could be better used on other projects.

The relatively low construction cost and the ability to shorten deliveries into adjacent territory where a sizable petroleum market exists were factors that favored construction of this terminal. A maximum of five products will be handled and transport loading will be from a two-spot rack. There will be no railroad tank car loading.

Station at Hillsboro, Minnesota

Farther north on this leg of the system, a pump station has been erected at Hillsboro, Minnesota, midway between the Fargo and Grand Forks, North Dakota, terminals, to increase line capacity into the latter location. Higher capacity was necessary for two reasons: Steadily increasing demand at the Grand Forks terminal, and construction of a new aviation fuels storage terminal, which is connected to the Great Lakes system at Grand Forks. This terminal is privately owned. The Hillsboro station presently is powered by a unit using a converted Allison aircraft engine. The temporary unit will be operated until permanent demands can be determined.

Satellite Terminal

At Olathe, a Kansas community southwest of Kansas City proper, a satellite type terminal with two 30,000-bbl tanks and a two-spot transport loading facility is being constructed. Besides the convenience for transporters hauling into this area and the elimination of several miles of driving through heavy traffic, the new terminal will take some of the load off the Kansas City terminal, which is operating near capacity. Products handled from Olathe will be restricted to two grades of motor gasoline.

At McCool junction, about midway between Lincoln and Grand Island, Nebraska, a connection was made with the new Kaneb line. A joint tariff arrangement will give Great Lakes shippers access to the territory served by Kaneb terminals at Norfolk and Yankton. Great Lakes tankage at the junction totals 100,000 bbl.

The rapid increase in refining capacity in central Kansas has imposed a steadily heavier demand on Great Lakes lines out of El Dorado. When the 10-in. line from there to Kansas City was built in 1955, (supplementing an 8-in. that feeds into the Great Lakes system at Humboldt, Kansas) its power was thought to be adequate for several years. With peak operation last winter warning of capacity trouble ahead, the 10-in. line's potential has been increased 48 percent by installation of an 1100-hp dual-fuel diesel powered unit at El Dorado and two electric units at Emporia and Lawrence. These are 1500 and 1250 hp outdoor horizontal units and are controlled from El Dorado, as is the older diesel station at Topeka.

Meanwhile, studies to improve the system continue and Great Lakes heads toward the end of 1959 and its first 100,000,000-bbl year. This will be more than 20,000,000 bbl better than the throughput for 1954, a pretty good indication that improvements made since then have kept the company headed in the right direction. ★

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Pipeline Projects

CONSTRUCTION FEATURE

FPC Okays Midwestern's Pipeline To Canada

Midwestern Gas Transmission Company's proposed $52,277,000 pipeline project to import Canadian gas into the Midwest has received Federal Power Commission approval, winding up long-pending proposals by the Tennessee Gas Transmission Company subsidiary.

Canadian authorities now must give their permission to export the gas.

Midwestern plans to build a 504-mile, 24-in. pipeline for the transportation and sale of about 200,000,000 cu ft per day obtained from Trans-Canada Pipe Lines, Ltd., at the Minnesota-Canadian border near Emerson, Manitoba.

The proposed line would terminate at a point near Marshfield, Wisconsin, where 158,000,000 cu ft per day would be sold to Michigan Wisconsin Pipe Line Company. The FPC also approved the latter firm's $24,177,000 pipeline project to transport the gas it buys from Midwestern.

The commission conditioned its approval on Trans-Canada's getting necessary export authority from the province of Alberta and the Canadian Government. If Trans-Canada's applications, now before both the Alberta Oil and Gas Conservation Board and the National Energy Board, are approved, the company will build a 50-mile lateral of 30-in. pipe from its main line near Winnipeg to Emerson, with several compressor stations, at a cost of $32,000,000.

Transwestern Contractors Set Pipelaying Plans

The two prime contractors for Transwestern Pipeline Company's 1805-mile pipeline, that will deliver gas from Texas and Oklahoma fields to the California border, have announced pipelaying plans.

December 1 marks the start of pipelaying by Houston Contracting Company of 149 miles of 30-in. from the vicinity of Corona, New Mexico, west to the vicinity of McCartys, and 61 miles of 20-in. and 76 miles of 24-in. from the vicinity of Fort Stockton, Texas, northwest to the vicinity of Carlsbad, New Mexico.

Initial headquarters for the Corona-McCartys section will be in Corona, and personnel named include: L. A. Young, superintendent; K. W. Berlin, assistant superintendent; and L. F. Redfearn, field office manager. Initial headquarters for the Fort Stockton-Carlsbad section will be in Fort Stockton, and personnel include: A. J. Slovack, superintendent; L. L. Patterson, assistant superintendent; and Ralph Axsom, field office manager.

About December 10, Houston Contracting will begin laying approximately 55 miles of 30-in. and 89 miles of 24-in. from the vicinity of Corona, east to Roswell, New Mexico, and southeast to Carlsbad. Roswell will be the site of initial headquarters. M. L. Thompson has been named superintendent; Talmadge Crabtree, assistant superintendent; and George Warner, field office manager.

Work will be done later by the same spreads on approximately 166 miles of 24-in. from Roswell, northeast to the vicinity of Dawn, Texas.

Houston Contracting has a joint contract with R. H. Fulton and Company and Western Pipe Line, Inc., calling for the construction of 300 miles of 10, 12, and 16-in. trunk lateral lines in the Texas-Oklahoma Panhandle and the West Texas-New Mexico area.

Two H. C. Price Company spreads will be responsible for construction of 335 miles of 30-in. pipeline across Arizona.

Superintendent G. A. "Abe" Reutzel, spread one, and his pipeline crews have commenced construction from their headquarters set up at Window Rock, Arizona, near the Arizona-New Mexico border, and will work west. Office manager is Ernest Dickson.

Spread two under the supervision of R. L. "Bob" Ezell, will begin their portion of the line at the California-Arizona border, and work east. Spread headquarters have been established at Kingman, Arizona, with Joe C. Eakin, office manager.

Price's B. V. "Barney" Elliott is supervising double jointing at yards in Gallup, New Mexico, and Kingman, Arizona. Merle E. Levitt is rack foreman at Gallup, and Don Barcus at Kingman.

Four Companies File "Budget" Applications

Budget-type construction applications have been filed with the Federal Power Commission by four companies —American Louisiana Pipe Line Company, Transcontinental Gas Pipe Line Corporation, Lone Star Gas Company, and Northern Natural Gas Company.

American Louisiana seeks to construct facilities totaling not in excess of $3,000,000, with the cost of any single project limited to $500,000.

Transco and Lone Star each propose construction totaling $1,000,000, with a single project limitation of $250,000 for each company.

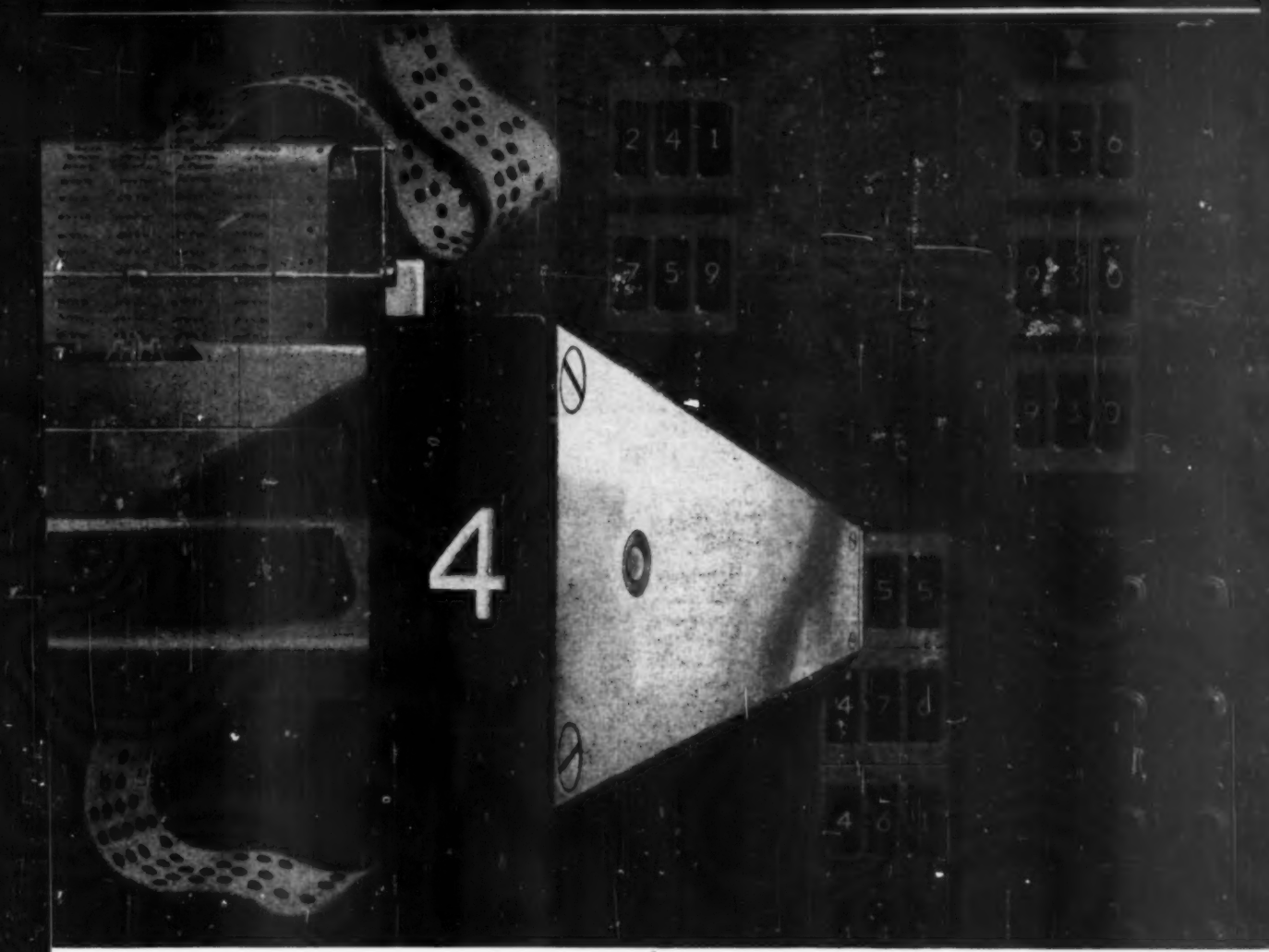
All facilities would be built within a 12-month period and would enable each applicant to take into its pipeline system natural gas purchased from producers in the general area of its transmission line.

Northern Natural seeks authority for the construction of up to $4,000,000 in pipeline facilities during 1960 to enable it to transport and receive into its system natural gas available from numerous relatively small producing areas in Texas, Oklahoma, and Kansas. Northern said that no single project would exceed $500,000 in cost.

International Notes . . .

In Italy, results of a technical study of proposed oil and/or natural gas pipelines from Tunisia to Bavaria are under study. A proposed line would cross Sicily to Messina and the Italian mainland. It would be tied to construction of a proposed bridge across the Straits of Messina.

A gigantic pipeline project that will tie satellite countries closer to Moscow and advance Russia's strategic supply lines deeper into the heart of Europe is underway. The Soviet, in close cooperation with its east European satellites, is building a 2500-mile pipeline which will carry oil from the Urals to Poland, East Germany, Hungary, and Czechoslovakia. At the same time Moscow is working on another line which is to bring Soviet oil to the shores of the Baltic for the needs of the Scandinavian nations as well as those of Russia's strategic Baltic fleet. The new intra-bloc pipeline, planned for completion within four years, will have a total volume currently estimated at 111,810,000 bbl.



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Projects

Engineering To Start On Alaskan Gas Line

Engineering will begin immediately for a natural gas pipeline to serve Anchorage, Alaska.

Announcement came from the Anchorage Gas Corporation, which has negotiated a firm gas purchase contract with Union Oil Company of California and the Ohio Oil Company whereby the latter will supply an estimated 200 billion cu ft during the next 20 years.

Anchorage area residents recently voted almost two to one in favor of granting a franchise to the Anchorage Gas Corporation, whose president and three other directors reside in Houston, Texas.

The pipeline, construction of which is expected to commence in the spring, will be up to 12-in. in diameter, will extend approximately 165 miles from a production area recently discovered by Union and Ohio, and will cost from $12,000,000 to $15,000,000. This cost will include the necessary gas gathering system from wellheads and dehydration facilities.

Anchorage's local gas distribution system will entail another expenditure of $4,000,000 to $5,000,000, according to President Robert B. Baldwin of Houston.

The Union-Ohio discovery, Alaska's first commercial gas production, is on the Kenai Peninsula about 80 miles south of Anchorage.

Tennessee LPG Line Planned

The Interstate Petroleum Corporation of Tennessee has been organized in Memphis, Tennessee, to construct a liquefied petroleum gas pipeline from that city into the mid-South.

The new firm will build a connection with the Oklahoma-Mississippi River Products Line, Inc., which delivers petroleum products from D-X Sunray Oil Company refineries at Duncan, Oklahoma, and West Tulsa, Oklahoma, to the tank farm at West Memphis, Arkansas.

Bay Plant, Products Line

Completion of a 13-mile, 4-in. pipeline and a new natural gas processing plant has been announced by Bay Petroleum Company, a division of Tennessee Gas Transmission Company.

The plant is on Copano Bay about eight miles northeast of Rockport, Texas. The line extends from the Copano Bay site to a products pipeline that Bay operates along the Texas Gulf Coast.

United Gas Gets OK, Producers Conditioned

Granting authority to United Gas Pipe Line Company to build 14.4 miles of 12-in. pipeline and four purchase meter stations, the Federal Power Commission at the same time authorized two independent producers to sell natural gas to United Gas but conditioned the certificates to limit the initial price of the gas to 15 cents per Mcf, 2 cents below the proposed 17-cent level.

The FPC's action modifies a decision issued last May 15 by Presiding Examiner Richard N. Ivins, who authorized the sales but did not include any price conditions in the certificates. The Commission held that the conditioned price of 15 cents "is required by the public convenience and necessity."

The producers are Phillips Petroleum Company and Union Producing Company.

United Gas' facilities for receiving gas from the North Henderson field area of Rusk County, Texas, will cost an estimated $696,369 and will enable it to receive eventually into its existing system 24,000,000 cu ft per day.

Canadian News Notes

Alberta Gas Trunk Project Unopposed, Approved

The Alberta Gas Trunk Line Company, Ltd., has received the Alberta Government's permission to build its Foothills division following an earlier formal hearing at which no opposition was presented.

The $103,145,200 system will handle all gas to be delivered from Rocky Mountain Foothills area fields to Alberta and Southern Gas Company, Ltd., for its big export project.

The Trunk Line job will consist of 386 miles of 24 to 36-in. main line and 274 miles of laterals in diameters up to 24 in. Engineering is by Canadian Bechtel, Ltd.

Contractors Working Late On Alberta Gathering Lines

Contractors are working late this fall laying natural gas field gathering systems for companies that are to be connected to the Alberta grid system of The Alberta Gas Trunk Line Company, Ltd.

Banister Helm, Ltd., Edmonton, has completed the largest job, 43 miles of gas gathering lines in the Hussar field, with pipe sizes from 2 in. through 8 in. The work was done for Tennessee Gas Transmission Company, principal operator in the field. Inspection was performed by Hudson Engineering (Canada) Ltd., under chief inspector Shorty Abells.

Martin Balaski was spread superintendent for the contractor. Foremen: Paul Watson, ditch; Ole Carlson, pipe; Steve Slade, dope and lowering in; Gordon Olsen, right-of-way cleanup; L. Work, office manager; Moe Cuthbert, material man.

Banister Helm has also completed 18 miles of gathering lines for The California Standard Company in the Nevis field, in pipe sizes from 2-in. through 10-in. Pryde-Flavin Engineering, Ltd. had the inspection, with P. G. Clarke chief inspector. George Caron was spread superintendent. Foremen: G. Dorey, pipe; L. Bremner, lowering in; W. Streit, right-of-way and cleanup; N. Waldbillig, field office manager.

A smaller Banister Helm job, also completed in October, was 10 miles of 6-in. lateral to connect the Hairy Hill field with the trunk line. Owner is Cretaceous Pipeline Ltd.

Mannix Finishes Three Alberta Construction Jobs

Mannix Company, Ltd., Calgary, has laid a small natural gas gathering system in east central Alberta for Cold Lake Pipe Line Company, Ltd. The project consisted of 13½ miles of 6-in. to supply gas from the Cold Lake and Bonnyville fields to adjacent defense bases and towns.

It was completed on October 31.

The construction contract was a package deal, including engineering, supply of materials, and construction. Engineering was done by the Mannix head office in Calgary.

A crude oil gathering system for Federated Pipe Lines, Ltd., in the Swan Hills field of north central Alberta was completed the middle of October. V. J. (Slim) Worcester was spread superintendent. The project comprised 40 miles of 4-in. to 10-in. pipe.

A continuing contract for Pembina Pipe Line in the Pembina oil field consisting of 50 miles of 3-in. through 10-in. gathering lines was completed on October 31. S. W. Steffen was spread superintendent.

WITH THE PIPELINE CONTRACTORS

● **APV Company, Inc., 1801 Continental National Bank Building, Fort Worth, Texas.** Has been awarded contract to construct 61.4 miles of 30-in. from Pollock, Louisiana, to valve 63 for *Trunkline Gas Company*. Field office is in Pollock. A. Vaughn is superintendent, and W. L. Huff is spreadman.

● **B & G Construction, P. O. Box 776, Burkburnett, Texas.** Has been awarded a contract by *Mobil Oil Company* to construct five miles of 6-in. pipeline in the vicinity of Burkburnett, Texas.

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has been awarded a contract to lay 9.5 miles of 30-in. gas pipeline for *Houston Pipe Line Company* between South Houston and Deer Park, Texas, the first section of a 27-mile line that eventually will be built from Houston to Alvin, Texas. Murphy Kidd is job superintendent, and South Houston is field headquarters.

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Has contract to construct 120 miles of 8 in. through 14 in. for *South Texas Natural Gas Gathering Company* in south-central Texas. Has received contract to build 60 miles of 8-in. products line for the *Ohio Oil Company* from Adrian to Samaria, Michigan, with field office in Somerset, Michigan, Ken Dickison as field office manager, and Mac Hoffman as supervisor.

● **Sam Carline, Inc., P. O. Box 138, Berwick, Louisiana.** Has been awarded contracts by *United Gas Pipe Line Company* for the laying of 9.5 miles of 16-in. pipeline south of Houma and 5.2 miles of 16-in. south of Morgan City, Louisiana, with field office for the former located at Houma under Jack Gibbs, superintendent, and field office for the latter at Berwick. Has received a contract from *Texas Gas Transmission Corporation* to construct 18 miles of 12-in. pipeline east of Baldwin, Louisiana, into the Atchaflaya Basin, with Bob Bethea as superintendent.

● **Contracting & Material Company, 1235 Dodge Avenue, Evanston, Illinois.** Is laying 62.2 miles of 26 in. for *Trunkline Gas Company* from Tuscola to Rossville, Illinois.

● **Engineers Limited Pipeline Company, 11858 San Pablo Avenue, El Cerrito, California.** Has been awarded a contract by *Trunkline Gas Company* to construct 136 miles of 26-in. pipeline from Rossville, Illinois, to the Indiana-Michigan border. H. H. Mehail will supervise the first spread at Fowler, Indiana, and Jake Cheeves will supervise the second spread at Goshen, Indiana.

● **Fulton Banister, Ltd. 625 Northern Hardware Building, Edmonton, Alberta, Canada.** Has received a contract to construct a positive displacement system at *Interprovincial Pipe Line Company's* Edmonton station. T. J. Robertson is project engineer.

● **R. H. Fulton & Company, P. O. Box 1526, Lubbock, Texas.** Has been awarded a contract by *Continental Pipe Line Company* to lay 155 miles of 6-in. pipeline from Artesia, New Mexico, to El Paso, Texas, with field office at Artesia under the supervision of H. L. Tinkler. Has been awarded a contract to lay 94 miles of 20 and 24-in. pipeline for *Northern Natural Gas Company* in Minnesota. The south spread field office is at Hastings under Truman Clayton, spreadman. North Branch is the site for the north spread field office, with H. A. Veach as spreadman. Has been awarded a joint contract with Houston Contracting Company and Western Pipe Line, Inc., to lay approximately 300 miles of 16, 12, and 10-in. trunk lateral lines in the Texas-Oklahoma Panhandle and West Texas-New Mexico area for *Transwestern Pipeline Company*.

● **Grayco Constructors, Inc., P. O. Box 4147, Austin, Texas.** Has contract with *Trunkline Gas Company* to lay a 53-mile, 30-in. line between Pitkin and Pollock, Louisiana.

● **Groninger & King, Inc., P. O. Box 1381, Pampa, Texas.** Has been awarded a contract by *Northern Natural Gas Company* to construct 12 miles of 4 and 6-in. gathering lines in Texas, Oklahoma, and Kansas, under the supervision of W. G. Puckett.

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Contractors

● **Harbert Construction Corporation, Box 1369, Birmingham, Alabama.** Has been awarded a contract by *Southern Natural Gas Company* to construct 22 miles of 20-in. pipeline between Culloden and the Ocmulgee Station in Georgia and 20 miles of 14-in. from Griffin, Georgia, to the Ben Hill Station. Tommy Rashell is superintendent at the field office in Forsyth.

● **Henuset Brothers, Ltd., P. O. Box 657, Virden, Manitoba, Canada.** Has been awarded a contract by *Saskatchewan Power Corporation* to construct 45 miles of 6-in. natural gas pipeline connecting the new casinghead-gas recovery plant of Imperial Oil, Ltd., in the Alida oil field with Saskatchewan Power's main transmission line in the Steelman oil field.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has contract to lay approximately 74 miles of 30-in. natural gas pipeline for *Texas Gas Transmission Corporation* in central and north Louisiana, with R. L. Silar as superintendent. Has been awarded a contract to construct 27 miles of 20-in. natural gas pipeline and three 12-in. Mississippi River crossings for *United Gas Pipe Line Company* in the vicinity of Empire, Louisiana, below New Orleans. R. E. Thornton is superintendent. Is constructing 17 miles of 12-in. and smaller lateral lines for *Gulf Oil Corporation* in the Puckett Field in Pecos County, Texas, under the supervision of Sam Downing at Fort Stockton, Texas. Has been awarded a contract by *Transwestern Pipeline Company* (see details, *Pipeline Projects*).

● **Joyce Western Corporation and Joyce Pipeline Company, Box 385, Andover, New York.** Has been awarded a contract by *Peoples Natural Gas Company* to construct 27 miles of 20-in. line between Bentleyville and Imperial, Pennsylvania, under the supervision of Charles Joyce, and 24 miles of 10 and 12-in. between Ligonier and Somerset, Pennsylvania, under the supervision of Lyle Ostrander. Has received a contract from *Iroquois Gas Company* to lay 11 miles of 16-in. between Hamburg and Buffalo, New York, with L. G. Duke as field office manager. Has been awarded a contract by *Manufacturers Light and Heat Company* to lay 12 miles of 6-in. line between Medix Run and Penfield, Pennsylvania.

● **C. S. LeNoir Construction Co., P. O. Box 798, Austin 64, Texas.** Is constructing 57 miles of 30-in. line for *Trunkline Gas Company* between Union City and Henning, Tennessee. W. B. Williams is superintendent. James Keene is spreadman, and R. E. McManus is office manager at the field office in Halls. Has received contracts from *Southern Natural Gas Company*, for 19 miles of 24-in. near Enterprise, Mississippi: and 43 miles of 20-in. between Wetumpka and Auburn, Alabama. C. H. LeNoir is spreadman and F. A. Phelps is office manager at Enterprise.

● **H. A. McGinnis Construction Co., North Dumas Avenue, Dumas, Texas.** Has been awarded contracts by *Phillips Petroleum Company* and *J. M. Huber Corporation* for an undetermined amount of 2 through 12-in. pipeline in Hutchinson County, Texas, and from *Shamrock Oil and Gas Corporation* for an undetermined amount of 2 through 12-in. in Moore County, Texas. Dumas, Texas, is the field office for all three jobs.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Contractors

● **Oklahoma Contracting Company, P. O. Box 13227, Dallas 20, Texas.** Has been awarded a contract by *Southern Natural Gas Company* to construct 80 miles of 18-in. from Prentiss to Cranfield, Mississippi. L. Creech is superintendent at Brookhaven, Mississippi.

● **Panama, Inc., 2201 Commerce Building, Houston 2, Texas.** Has been awarded a contract to lay 118 miles of 30 in. from Kilbourne, Louisiana, to Ballentin, Mississippi, and 60 miles of 30 in. from Brownsville to Canadaville, Tennessee, and from Bardwell, Kentucky, to Polk, Tennessee, for *Trunkline Gas Company*.

● **H. C. Price Company, Price Tower, Bartlesville, Oklahoma.** Has been awarded a contract by *Transwestern Pipeline Company* (see details, *Pipeline Projects*).

● **Sherman, Allen, Gay & Taylor, Inc., 3115 Buffalo Drive, Houston, Texas.** Has received a contract from *Pan American Argentina Oil Company* for construction of 107 miles of 6, 10, 12, and 14-in. crude lines from the Comodoro Rivadavia oil field in Argentina to the company's pipeline facilities on the Atlantic Coast. Dick Plake is field superintendent. Has been awarded a contract by *Trunkline Gas Company* to build 42 miles of 24-in. pipeline in Liberty and Hardin counties, Texas, with field office at Liberty under the supervision of E. D. Singleton.

● **Sheehan Pipe Line Construction Company, 514 National Bank of Tulsa Building, Tulsa, Oklahoma.** Has received a contract from *Transwestern Pipeline Company* to construct an undetermined amount of 4, 6, and 8-in. gathering lines in West Texas, Oklahoma, and New Mexico. Field office will be located at Higgins, Texas, under the supervision of J. W. Brown.

● **Stelco, Inc., 905 Barton Springs Road, Austin, Texas.** Has been awarded a contract by *El Paso Natural Gas Company* to lay an undetermined amount of various size lines in the Shamrock field under the supervision of Al Blanchard and W. K. Hancock.

● **Turriff-Burden, Ltd., (subs. Burden International, Ltd., Box 5216, Tulsa, Oklahoma).** Has been awarded a contract by the *Iraq Petroleum Company, Ltd.*, for the construction of 315 miles of 30 and 32-in. pipeline from Kirkuk to the Syrian border and connecting Rumaila and Fao. The project office in London, England, will be managed by W. T. Barker. Field construction superintendent is John H. Miller; assistant superintendent is Arnold Smith; and manager of the field office in Baiji, Iraq, is G. E. Suagee.

● **Western Pipe Line, Inc., P. O. Box 1076, Austin, Texas.** Has been awarded a contract by *Transwestern Pipeline Company* to construct 100 miles of 10, 12, and 16-in. laterals in the West Texas-New Mexico area.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has been awarded a contract by *Northern Natural Gas Company* to lay 78 miles of 20-in., 11 miles of 16-in., 10 miles of 12-in., and 10 miles of 10-in. pipeline in Minnesota, as well as a St. Louis River crossing, with spread No. 1 headquarters designated at Pine City, Minnesota, under Don Foster, and spread No. 2 under Harlan Evens. Another contract with *Northern Natural Gas Company* calls for installation of 56 miles of 10 and 12-in. pipeline from Brainerd to St. Cloud, Minnesota.

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Digging from 36 to 52 inches wide at depths to 7½ feet, this heavy-duty wheel-type machine produces up to 25 lineal feet of trench per minute. With all this extra capacity you still get smooth, precision wheel control. Double-action hydraulic rams actuate digging wheel — give infinite depth selections, maintain close grade tolerance in toughest digging. Heavy-duty wheel has formed steel-plate buckets, solid or tine-back, with replaceable point-type teeth.

Hydraulic control system on conveyor gives belt speeds up to 621 feet per minute — *completely independent of digging wheel speeds.* Belt easily handles maximum yardage from the extra-wide wheel — puts spoil bank well back beyond edge of trench. See Parsons distributor, or write for more facts.

Need deeper trenches on your cross-country work? Then check this larger companion model 520 Trenchliner. It produces up to 28 lineal feet of trench per minute — 40 to 52 inches wide at depths to 8½ feet. Parsons offers a complete line of wheel and ladder-type Trenchliners. In addition to the 420 and 520, there are 3 smaller wheel types — and a choice of 5 heavy-duty ladder type Trenchliners.

Mail to: PARSONS COMPANY, NEWTON, IOWA *Send literature on:* ☐ 420 Trenchliner ☐ 520 Trenchliner

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TITLE_____

COMPANY_____

DIVISION_____

STREET_____

CITY, STATE_____

(A Division of Koehring Company) P832 PB

TRENCHLINERS for PIPELINERS

PIPELINE PERSONALS

Maurice N. Day

Maurice N. Day has been appointed assistant chief engineer of Michigan Wisconsin Pipe Line Company and American Louisiana Pipe Line Company. Day joined Michigan Consolidated Gas Company in 1949 and since 1951 has been assistant to the engineer, assisting in plans for company expansion.

O. R. Burden, president of O. R. Burden Construction Corporation, has formed a new company, Universal Engineers and Constructors, Inc., with headquarters in Tulsa. Burden will be president of the company. **D. O. Givens,** former executive vice president of Refinery Engineering Company, has been named executive vice president and general manager. Other officers will be **Verne L. Snow,** vice president; **H. D. Peters,** treasurer; and **J. Ray Stough,** manager of sales.

Orville S. Carpenter, president of Texas Eastern Transmission Corporation, has been elected a director of Algonquin Gas Transmission Company.

FIRST

first off-shore sulphur production in the

world will move through Reilly-coated lines

Seven miles off Grand Isle, Louisiana, sulphur will be raised by the Freeport Sulphur Company from a mine 2,000 feet below the ocean floor. Reilly Hot Coal Tar Enamels—Hot Service Enamel with HS X-1 Primer—applied by Pipe Line Service Corporation—will protect delivery lines to shore installations against salt water and other corrosive elements. Inquire at any Reilly Sales Office.

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Reilly COAL TAR PRODUCTS

ARMEO Protective Coatings

Sales offices in principal cities

Deane Baker

Deane Baker, formerly of Deane Baker and Associates in Lubbock, Texas, has joined the executive staff of the Somerville Construction Company. According to company president **Robert B. Somerville,** Baker will work in all phases of executive responsibility from public relations to construction. Baker organized his own petroleum management consulting firm in 1957 after serving as vice president of R. H. Fulton and Company.

D. L. Weinert of Okan Pipeline Company and **Gerald A. Boyer, Joe R. Grisham, Carrol L. Rathbun, A. V. Spitser,** and **T. O. Turpin,** all of Great Lakes Pipe Line Company, were recently announced to be new members of The Pipe Liners Club of Tulsa.

Carl J. Coulter, assistant superintendent of Cities Service Gas Company's pipeline department, has been named chairman of the company's safety committee for a one-year term.

Hugh A. West, a veteran pipeliner, has been named manager of the operations section of Atlantic Pipe Line Company's southwestern division, filling the vacancy created when **W. S. Schmidt** became general manager of the division replacing the retiring **J. Harry Wood, Jr.** Before his appointment, West was superintendent of the West Texas region. **R. G. (Dick) Dulaney,** who was assistant superintendent of the West Texas region, was named to succeed West.

Francis J. McElhatton, Edward J. Ingram, and **Robert B. Harkins** have been elected vice presidents of Panhandle Eastern Pipe Line Company. McElhatton, in charge of gas gathering and transmission, is a 23-year veteran with the company, having served first as an engineer, then superintendent of corrosion and communications, assistant superintendent and later superintendent of compressor stations, and superintendent of transmission. He was made general manager of gathering and transmission when the operating department was reorganized in late 1956. Ingram will be in charge of rates and economics, and Harkins in charge of production and gas supply.

W. M. Little has been appointed vice president and manager of operations for North Carolina Natural Gas Corporation. He served previously as project engineer for R. A. Ransom Company, Inc., in the construction of a 630-mile transmission system for North Carolina Natural Gas.

Oliver M. Fletcher, engineer for Texas Eastern Transmission Corporation, has been named acting assistant supervisor of design and construction in the company's engineering department, according to **A. J. Shoup,** vice president and chief engineer.

John G. (Jack) Smith, East Bay division gas engineer for Pacific Gas and Electric Company, has been transferred to Calgary, Alberta, Canada, to serve as executive assistant to the vice president and manager of Alberta and Southern Gas Company, Ltd., PG&E's gas-purchasing subsidiary, and to assist in preparations for a pipeline system to transport natural gas from Alberta to the Bay area of California.

It's New | Pipeline Equipment

Anti-Friction Unit For Gate Valves

A new anti-friction unit for gate valves that employs a self-sealing synthetic rubber seal gasket is said to assure higher working pressures, to be drop tight, and to eliminate the need for mechanical operators. The anti-friction unit is designed for sizes 2 through 30-in. standard and through conduit gate valve in cast steel, cast iron, cast aluminum, and bronze and from 0 through 10,000 psi working pressure with temperature ranges of minus 60 F to plus 350 F. The anti-friction unit, which may be used with either screwed, welded, or flanged ends, consists of a tapered wedge assembly mounted on roller bearings that controls the movement of the valve discs. Initial closing and opening movement of discs is in a horizontal plane, directly against or away from the valve seats. *Charles Wheatley Company.*

Circle number (81) on reply card.

Vinyl, Butyl Laminated Tape

A new vinyl and butyl laminated pipe-wrapping tape is announced. Warco Laminated Tape's heavy mastic layer of butyl provides a permanent seal which fills all pits and prevents moisture migration at the overlap and provides a shock-absorbing cushion which "gives" under impact, thereby lessening the possibility of cuts or tears. The tough outer cover of vinyl is designed to provide a maximum resistance to both abrasion and punctures from backfilling. Applied, either by hand or machine, with a specially compounded primer that provides pipe surface preparation for maximum bond strength, the new Warco tape cannot be stripped from a properly wrapped pipe without leaving some of the inner layer of butyl, it is stated. *West American Rubber Co.*

Circle number (82) on reply card.

Phone Service for 2-Way Radio Equipped Vehicle

A new electronic device for use with two-way mobile radio communications, known as "Carterfone," allows the operator of private two-way radio equipment to talk from a mobile unit into any public telephone service, local or long distance. A telephone contact is established between the operator of a base station and any party with available public telephone service. The telephone handset at the base station is then placed in the specially designed Carterfone cradle. The voice of the person over the telephone—through the Carterfone—places the station on the air, transmitting his voice to the mobile unit receiver. When he ceases to speak, the base station automatically returns to receiving position—and the mobile unit speaker's voice is carried through the Carterfone into the telephone handset. It is completely transistorized and requires no additional installation in mobile units. *Carter Electronics Corp.*

Circle number (83) on reply card.

Controlled Rectifiers

Announced is the immediate commercial availability of a complete line of diffused silicon P-N-P-N controlled rectifiers — a new 4-layer semiconductor device for use in regulated power supplies, reversing drives, light dimming devices, surge voltage suppression, latching relays, and many other totally new applications. The TI Type-130 series differs from earlier 4-layer devices in that they utilize a third lead, known as a "gate," to control the current passing through the unit. A small typical current of 5 ma is used to "fire" the device. They are available in a welded, stud-mounting configuration with the gate and cathode leads located opposite the anode stud. They feature 50 to 400 v in both PIV and breakover voltage with an average rectified forward current of 3 amp at 50 C, 1 amp at 125 C. The devices will operate to 150 C, stud temperature, and a maximum one time surge current of 30 amp can be tolerated. *Texas Instruments Inc.*

Circle number (84) on reply card.

Stops Wear, Rebuilds

A new process for hardfacing — spray-welding a Ceramic powder — has been announced. According to the manufacturer, spray-welded Cermet actually fuses with the parent metal to stop corrosion and can also rebuild a variety of worn parts such as valves, spindles, transmission shafts, blades, dies, and pump sleeves. *Republic Hardfacing Corporation.*

Circle number (85) on reply card.

Offers Compensated Thermal System

An indicating pneumatic controller for temperature or pressure, offering a fully compensated thermal system as a standard feature and reset action as an optional feature, now is available. The unit, designed as a controller, transmitter, or receiver-controller, features a "clean" internal design to facilitate servicing or changes of functions while in an installed position. The new controller permits quick adjustment of the control point, proportional band, control action, and reset action. No tools are required for these adjustments. *Fulton Sylphon Div., Robertshaw-Fulton Controls Co.*

Circle number (86) on reply card.

Self-Propelled Generator Set

A self-propelled generator set that can take itself anywhere an ordinary vehicle can go, without need of tying up a second vehicle to pull it, soon may provide mechanical convenience and power-house utility to many pipeline-laying operations. It was originally conceived as a vehicle to serve commercial jet airliners, but its mobility, power, and flexibility are said to make it equally suited to pipelining needs for portable power. It can be further equipped with an electric welding machine, and for rough terrain it also can be equipped with larger wheels. The 48-in. high unit is available in ranges from 30 kva up to 250 kva. Electric output is primarily 60 cycle or 400 cycle a-c with an auxiliary d-c source. U. S. Steel provides a major part of the steel for the body. *Stewart & Stevenson Services, Inc.*

Circle number (87) on reply card.

Tractor-Shovel Has 100-Hp Diesel Engine

The newest Case Terraload'r is the W-10, a 4-wheel drive, rear-wheel steer tractor-shovel with a carry capacity of 6500 lb at 4 mph and a lift capacity of 13,000 lb at 0 mph. It is powered by a Case-built 401 cu in., 6-cylinder, 100-hp diesel engine; and all-weather starting on diesel fuel is assured by 24-v electrical system with positive engaging starting motor, and engine decompressor mechanism which releases compression for fast engine turn-over. Optimum power-to-weight ratio minimizes wheel slippage and consequent tire wear; and rear wheels carry over 40 percent more empty weight than the front wheels, providing greater digging traction and less bucking, enabling operator to quickly fill the 2 cu yd standard bucket and carry heaped loads at higher speeds. All moving loader parts are mounted ahead of the operator. *J. I. Case Company.*

Circle number (88) on reply card.

New Cast Steel Valve

The new Triangle through-conduit pipeline valve in cast carbon steel is designed to meet the need for a valve with smooth, clear passage, to allow for use of "pigs" yet with a positive shut-off in the rugged conditions of pipeline service. Where required, valves can be changed from manual to motor operation very simply, since a flange with dimensions equivalent to standard actuators or bevel gears has been incorporated in larger sizes. This valve is made in sizes from 6 to 30-in. for maximum cold working pressures from 275 psi to 1440 psi. *Triangle Valve Company, Ltd.*

Circle number (89) on reply card.

For Speediest Repair of Corrosion Leaks in Pipe

JUNIOR

EMERGENCY PIPE CLAMP

Repair pipe leaks QUICKLY!

Speediest application — slotted lug permits the single plated bolt to slide instantly into place.

A companion to the old reliable Emergency Pipe Clamp that has served industry for a half century, the JUNIOR, a single bolt clamp, is 2⅞" wide. Undersells most band-type clamps.

Made of malleable iron, ruggedly proportioned, with full-length hinge along one side. Formed to exact pipe size—no bending. The recessed pressure-equalizing gasket, entire width of clamp, is cemented in. A lasting installation. 2" pipe size—$1.80; 2½"—$2.20; 3"—$2.30. Write for new circular on the Junior.

SKINNER-SEAL

EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

Send for catalog!

M. B. SKINNER CO.

SOUTH BEND 21, INDIANA

New Equipment

Inspects Buried Coating

A detector that locates very small flaws or "holidays" in protective wrap of pipe several feet deep and shorts between pipelines—formerly made and used in the field by a leading utility—is now produced by the Pipetron Company. The portable unit consists of a transistorized transmitter that permits the easy inspection of several miles of pipe coating per day; a miniature receiver with a visual indicator; a search coil that doubles the receiver as a sensitive pipe locator; and several accessories. *Pipetron Company.*

Circle number (90) on reply card.

Safety Cleaner

Conco 1245 is formulated to meet the requirements of a safe and effective cleaner for equipment and such other areas as walls or floors. It is non-flammable, non-toxic, and is said to be effective in removing all types of soils, grease, or even carbon, and may be dispensed with mechanical equipment or by hand. It is diluted with up to 30 parts water for most cleaning operations, depending upon the type and degree of soil or stain. *Conco Chemical Company.*

Circle number (91) on reply card.

Small Tape Reader Set

A new punched-tape reader set—including transmitter-distributor, motor, base, and cover—is some 40 percent smaller in size and weight than previous models. Proposed for a wide range of tape reading applications including on-line data transmission over existing communications facilities, the Model 28 Miniaturized LXD set features facilities for sequential (serial) output, 100 wpm transmission, and reduced power requirements. Components are available separately (without motor, base, or cover) for integration with systems equipment. *Teletype Corporation.*

Circle number (92) on reply card.

Quiets Turbine Engines

A new, lightweight, acoustical shell type sound suppressor for gas turbine engines does not affect the operation, yet makes the unit inaudible at 200 ft. In the 6800 cps and 2400 cps frequencies, the new suppressor eliminates up to 85 percent of the objectionable noise and is said to be equally effective in reducing low frequency noise. *Curtiss-Wright Corporation.*

Circle number (93) on reply card.

Pipelayer Features Engine Change

The addition of a turbocharger, which aids in increasing engine flywheel horsepower to 140, is an engine change feature of Caterpillar's recently announced No. 572 Series D pipelayer. Engine torque rise has been increased 80 percent for increased lugging ability. Engine rpm has been increased from 1200 to 1240 to match the increased horsepower to the torque converter. The Caterpillar dry-type air cleaner is now on the No. 572 engine, reducing servicing time 75 percent. Other features noted include: Lifetime lubricated track rollers, carrier rollers, and idlers; "floating ring" feature of new seals to provide more end-play; and increased winch speeds for faster pipe handling. *Caterpillar Tractor Company.*

Circle number (94) on reply card.

You Can Depend On McCORD LUBRICATORS

MOST ENGINE BUILDERS DO!

Most Machinery On Display at the INTERNATIONAL PETROLEUM EXPOSITION Was Lubricated by McCORD

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It's New | Pipeline Literature

Valve "Buyers Guide"

For valve specifiers, users, and purchasers is a new "Buyers Guide" with valve comparisons, a list of frequently used abbreviations, a valve trim chart, and a breakdown of the OIC product line by valve material and pressure class, and classification by type, disc design, seating arrangement, stem operation, bonnet, and end connection. *The Ohio Injector Company.*

Circle number (95) on reply card.

For Arc Welding

A complete line of arc welding cable connections and accessories — including ground clamps, electrode holders, cable connectors, jacket grippers, cable splicers, and terminal connectors—is described in a new 12-page catalog. *Tweco Products, Inc.*

Circle number (96) on reply card.

Diesel Electric Plants

A 2-color folder describes and illustrates an entire new line of diesel engine-driven electric generating sets that provide a continuous source of electricity and emergency power for all types of heavy and light construction jobs. Specifications of these sets, in sizes ranging from 3000 to 6000 w (air-cooled) and from 10,000 to 230,000 w (water-cooled) are included. Diesel-driven marine electric generating plants are also described as are a complete selection of accessories and controls. *D. W. Onan & Sons, Inc.*

Circle number (97) on reply card.

Big Tractor Featured

The HD-21 crawler tractor, powered by Allis-Chalmers' recently introduced 225-hp turbocharged diesel 21000 engine, is the subject of a new 2-color catalog. Highlights of the engine and its combustion system; features of the hydraulic torque converter drive; components making up the matched power train; design and construction of main frame, truck frame, tracks, and similar components; plus a list of accessories available to increase the tractor's work capacity, all illustrated, are included in the new 16-pager, with the back page devoted to specifications and standard equipment of the tractor. *Allis-Chalmers Manufacturing Company.*

Circle number (98) on reply card.

Mass Flowmeter

Theory, operation, and advantages of the new gyro-integrating mass flowmeter that measures the flow of fuels, industrial liquids, and gases directly in pounds are related in a new bulletin. Ranges, specifications and dimensions, and cutaway drawings illustrating principles of operation are included. *General Electric Company.*

Circle number (99) on reply card.

Rectifier Bulletin

"Coreco" air-cooled and oil immersed rectifiers for cathodic protection are the subject of a new illustrated bulletin. Components are described. *Corrosion Rectifying Company.*

Circle number (100) on reply card.

Rotary Compressors

All-weather operation and other features of 6 models of rotary portable air compressors, ranging from 85 to 900 cu ft per min, are described in a new bulletin entitled "Rotary Portable Compressors." The engineering principles responsible for all-weather operation and the elimination of "dry starts" during cold weather are described by word and illustration. *Gardner-Denver Company.*

Circle number (101) on reply card.

Cartoons on Maintenance

A cartoon series featuring preventive tractor maintenance is offered free to owners and operators of construction equipment. Featuring cartoon characters in typical job situations, the 11-in. by 13-in. posters are suitable for tacking on field shacks, shop walls, and bulletin boards. *J. I. Case Company.*

Circle number (102) on reply card.

Safety Starters

Six important safety features of new combination starters used to control industrial equipment such as heavy machine tools are discussed in a new booklet. *Westinghouse Electric Corporation.*

Circle number (103) on reply card.

C-R-C Kelley Ripper Rips Rock and Frozen Ground Deeper

For Faster, More Profitable Ditching Operations

Nothing equals the powerful Kelley Ripper for ripping through rock, frozen ground, or hard-packed earth. Ripping up to seven feet deep even when the going is the roughest, the Kelley Ripper frequently eliminates the need for expensive ditch shooting.

Find out how the patented C-R-C Kelley Ripper can help speed up your ditching operations—write or call C-R-C for complete, descriptive details.

CONDENSED SPECIFICATIONS

ITEM	D-9	D-8	D-7
Weight Complete—Approx.	15,600 lbs.	12,500 lbs.	10,800 lbs.
Shank Sizes*—With Boot	3½" x 12" x 97" 3½" x 14" x 97" 3½" x 14" x 104"	3½" x 12" x 97"	2½" x 12" x 84"
Shanks Furnished	1	1	1
Boots Furnished	1	1	1
Width	118"	95½"	97"
Length	124"	107"	107"
Length—(Back of Tractor to Pivot Point of Shank)	114"	92"	92"
Maximum Depth	84"	72"	60"
Maximum Out-of-Ground	18"	18"	17"
Hydraulic Pump Capacity	1,000# Pressure 77 GPM @ 1200 RPM	1,000# Pressure 50 GPM @ 1200 RPM	1,000# Pressure 50 GPM @ 1200 RPM
Hydraulic Cylinders 2½" Ram Dia.	7" Dia. 48" Stroke	6" Dia. 48" Stroke	5" Dia. 42" Stroke

Above specifications subject to change without notice. *Other shank sizes available

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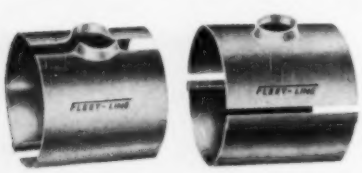
REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Full encirclement saddles.



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New Literature

Interchangeable Engines

Six-cylinder interchangeable diesel and carbureted engines are the subject of a new 12-page, three-color catalog. The publication deals with International's UC-221 and UD-236, rated at 75 maximum horsepower, and the UC-263 and UD-282, rated at 95 maximum horsepower. Each pair of carbureted and diesel engines is interchangeable in power and transmission. *International Harvester Company.*

Circle number (104) on reply card.

Argus Assembly Manual

An assembly language manual of "Argus", the automatic routine generating and updating system for the new Honeywell 800 all-transistorized electronic data-processing system, is in distribution. Argus reduces the time and effort required to code and check out programs for the Honeywell 800 by allowing the computer itself to perform the routine clerical operations. Programs written with the aid of the Argus assembly routine are independent of fixed memory locations and, therefore, may be modified, corrected, or expanded in Argus language by the computer. Automatic checkout routines also can be incorporated into assembled programs to permit rapid testing and program error correction. *DATAmatic Division, Minneapolis-Honeywell Regulator Company.*

Circle number (105) on reply card.

New Outriggers Described

New hydraulically operated "Power-Set" outriggers as available on Lorain Moto-Cranes are described in a new four-page bulletin as being the first power operated outriggers to use curved beams with attached floats that move out and down simultaneously to automatically adjust to ground level. *The Thew Shovel Company.*

Circle number (106) on reply card.

Recorder Specifications

Recording instrument information such as dimensions and chart speeds, operating specifications, applications, features, and accessories is the subject of a new bulletin which also describes such specialized recording instruments as spectrophotometers, recording vibrometers, automatic oscillographs, self-balancing potentiometers, and speed recording systems. The manufacturer's line of recorders are grouped by accuracy class (¼, 1, 2, and 3 percent), and photographs of all models discussed are included. *General Electric Company.*

Circle number (107) on reply card.

Heavy Fuel System

A new bulletin defines heavy fuels and explains how it is possible to burn them in Enterprise diesel engines. An illustrated description of a typical Enterprise engine heavy fuel system is included, and it is pointed out that this heavy fuel system may be used successfully in stationary power plants and marine installations. *Enterprise Engine & Machinery Company.*

Circle number (108) on reply card.

Butterfly Valves

Eight butterfly valve designs are presented in tabular form in a new 4-page condensed bulletin. Valve sizes range from 1 to 108 in., with pressure drops up to 1200 psi and temperature up to 2000 F. *Continental Equipment Co., Div. of Fisher Governor Co.*

Circle number (109) on reply card.

Oakite ECP...

Don't let your pipelines suffer from hardening of the arteries

Pipelines lined with scale and sludge act just like hardened arteries – impeding circulation, increasing the necessary pumping effort.

With pipelines, fortunately, there's a quick remedy. Full efficiency can be restored through cleaning by chemical circulation, using Oakite methods and materials ... getting the benefit of Oakite ECP.

What's ECP? It's an Engineered Cleaning Program that takes into account your own individual soil problems, your requirements, your equipment. The Oakite Engineer lends personal and experienced supervision to the program, insures that the job is done at lowest possible cost.

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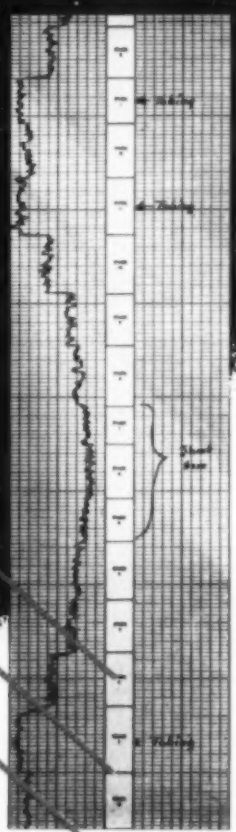
Lane-Wells new Directional Perforating Service safely and positively perforates a single string in a multiple string, tubingless completion on a single run in the well. The other casing strings in the well are not used in any way—they may be kept on production during the entire operation.

A Collar Log and a complete record of pipe and perforation orientation are made at the surface for positive checking at each stage of the operation.

For additional information about this new service ask your Lane-Wells representative or write:



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